La Moine/Missouri Creek Watershed Total Maximum Daily Load Study

Public Notice Stage 3 Report

1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276

Report prepared by:

With assistance from:

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Acronyms and Abbreviations

AFOs	animal feeding operations
AUID	Assessment Unit ID
AWQMN	Ambient Water Quality Monitoring Network
BMP	best management practice
CAFO	confined animal feeding operation
CFR	Code of Federal Regulation
CFU	colony forming unit
CREP	Conservation Reserve Enhancement Program
CSP	Conservation Stewardship Program
CV	coefficient of variation
CWA	Clean Water Act
DAF	average design flow
DMF	maximum design flow
EQIP	Environmental Quality Incentives Program
GHCND	Global Historical Climatology Network Database
GM	geometric mean
HSG	hydrologic soil group
HUC	hydrologic unit code
IDNR	Illinois Department of Natural Resources
Illinois EPA	Illinois Environmental Protection Agency
IPCB	Illinois Pollution Control Board
ISGS	Illinois State Geological Survey
L	liter
LA	load allocation
MGD	millions of gallons per day
MHP	mobile home park
mg	milligram
µg	microgram
mL	milliliter
MOS	margin of safety
MST	microbial source tracking
NLCD	National Land Cover Database
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NWIS	National Water Information System
RC	reserve capacity
SSM	singe sample maximum
SSO	sanitary sewer overflow
SSURGO	Soil Survey Geographic database
STEPL	Spreadsheet Tool for the Estimation of Pollutant Load
STP	sewage treatment plant
SWCD	soil and water conservation district
TMDL	total maximum daily load
USDA	United States Department of Agriculture
U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WLA	wasteload allocation

WQS	water quality standards
WWTP	wastewater treatment plant

Executive Summary

The Clean Water Act and U.S. Environmental Protection Agency (EPA) regulations require that Total Maximum Daily Loads (TMDLs) be developed for waters that do not support their designated uses. In simple terms, a TMDL is a plan to attain and maintain water quality standards in waters that are not currently meeting them.

This TMDL study addresses the approximately 851 square miles La Moine/Missouri Creek watershed located in west central Illinois. Four stream segments within the watershed have been placed on the State of Illinois §303(d) list; two of these segments were verified as impaired as part of this study and TMDLs have been developed.

The sources of pollutants in the watershed include NPDES permitted facilities such as wastewater treatment facilities and concentrated animal feeding operations. In addition, nonpoint pollution resulting from several key sources including stormwater runoff, onsite wastewater treatment systems, animal feeding operations, livestock populations, and wildlife.

A TMDL identifies the total allowable load that a waterbody can assimilate (the loading capacity) and still meet water quality standards or targets. The loading capacity for each stream is determined using a load duration curve framework. TMDLs are presented in Section 8. A TMDL is equal to the loading capacity for a waterbody, and that loading capacity is distributed among load allocations to nonpoint and background sources and wasteload allocations to point sources. The required pollutant reductions vary between zero and 96 percent, depending on the waterbody and flow condition.

An implementation plan is provided in Section 10 which includes potential implementation activities to address sources of pollutants. This plan, when combined with the entire TMDL study, is provided to meet U.S. EPA's Nine Minimum Elements for Clean Water Act section 319 funding requirements and includes an analysis of critical areas, extent of needed implementation, schedule, milestones, partners, and estimated costs.

The State of Illinois uses a three-stage approach to develop TMDLs for a watershed:

> **Stage 1** – Watershed characterization, historical dataset evaluation, data analysis, methodology selection, data gap identification
> **Stage 2** – Data collection to fill in data gaps, if necessary
> **Stage 3** – Model calibration, TMDL scenarios, and implementation plan

This final report represents a compilation of Stage 1, 2, and 3.

1. Introduction

The Clean Water Act and U.S. Environmental Protection Agency (U.S. EPA) regulations require that Total Maximum Daily Loads (TMDLs) be developed for waters that do not support their designated uses. In simple terms, a TMDL is a plan to attain and maintain water quality standards in waters that are not currently meeting those standards. This study addresses the approximately 851 square mile La Moine/Missouri Creek watershed located in west central Illinois. The headwaters for the La Moine River begins in the Upper La Moine watershed and waters within this portion of the watershed are being addressed in a separate study (Figure 1). Several waters within the La Moine/Missouri Creek project area have been identified as impaired and placed on the State of Illinois 303(d) list.

1.1 TMDL Development Process

The TMDL process establishes the allowable loading of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and instream conditions. This allowable loading represents the maximum quantity of the pollutant that the waterbody can receive without exceeding water quality standards. The TMDL also takes into account a margin of safety, which reflects scientific uncertainty, as well as the effects of seasonal variation. By following the TMDL process, States can establish water quality-based controls to reduce pollution from both point and nonpoint sources, and restore and maintain the quality of their water resources (U.S. EPA 1991).

The Illinois EPA will be working with stakeholders to implement the necessary controls to improve water quality in the impaired waterbodies and meet water quality standards. It should be noted that the controls for nonpoint sources (e.g., agriculture) will be strictly voluntary.

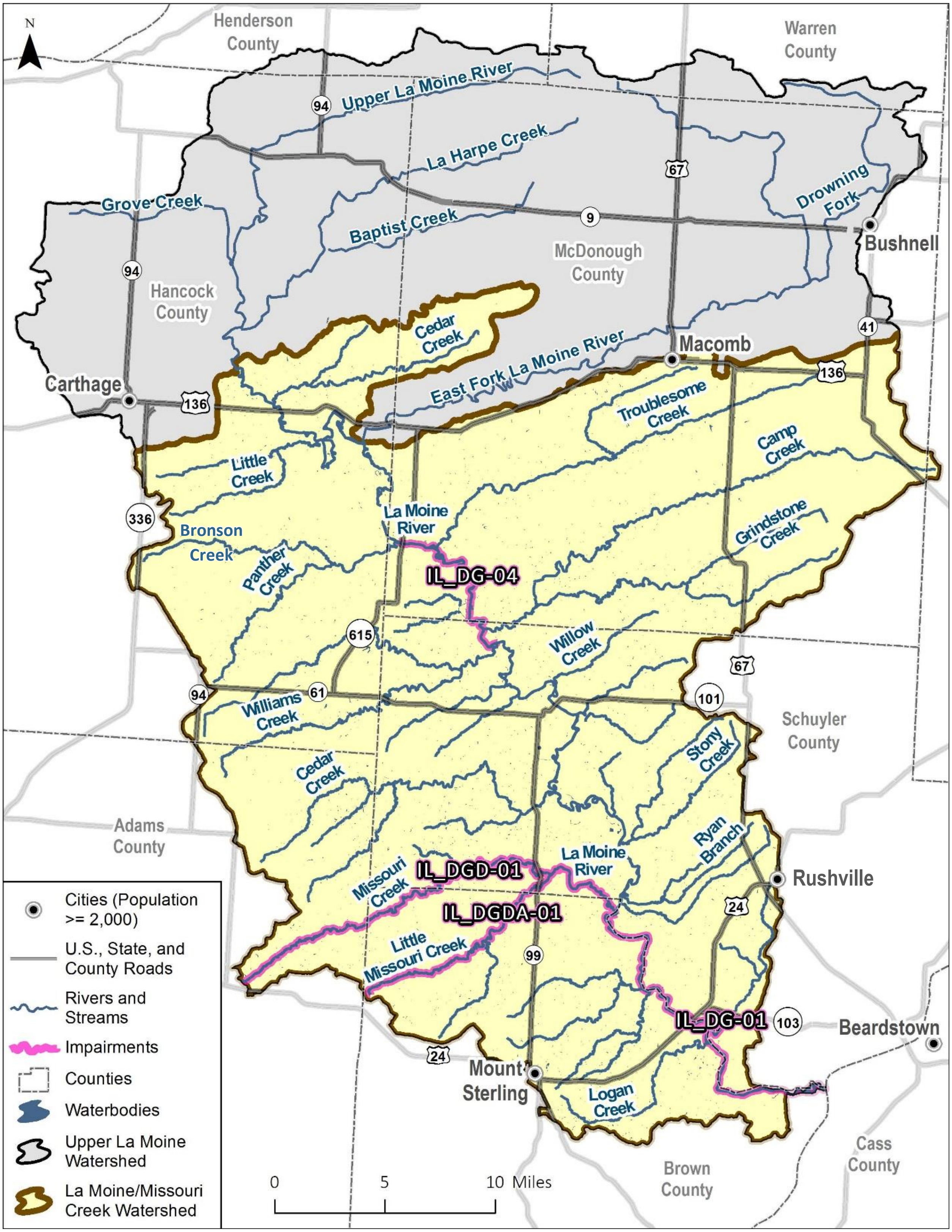

Figure 1. Upper La Moine River and La Moine/Missouri Creek River watersheds.

1.2 Water Quality Impairments

Several waters within the La Moine/Missouri Creek watershed have been placed on the State of Illinois §303(d) list (Table 1and Figure 1). This project is intended to address documented water quality problems in the La Moine/Missouri Creek watershed.

Table 1. La Moine/Missouri Creek watershed impairments and pollutants (2014, 2016 Illinois 303(d) Draft List)

Name	Segment AUID	Segment Length (Miles)	Watershed Area (Sq. Miles)	Designated Uses	TMDL Parameters
La Moine River	IL_DG-01	22.61	851	Primary contact recreation	**Fecal coliform**
La Moine River	IL_DG-04	11.38	396	Primary contact recreation	**Fecal coliform**
Missouri Creek	IL_DGD-01	27.55	92	Aquatic life	*Manganese*
Little Missouri Creek	IL_DGDA-01	15	37	Aquatic life	*Dissolved oxygen, manganese*

Italics – No TMDL provided. Missouri Creek (IL_DG-04) was determined to meet water quality standards (see Section 5) and Little Missouri Creek (IL_DGDA_01) was also determined to meet water quality standards (see Sections 5 and 6).
BOLD – TMDLs are provided in Section 8.

2. Watershed Characterization

The La Moine/Missouri Creek watershed is located in west central Illinois (Figure 1). The project area begins downstream of the Upper La Moine watershed at the confluence of the east fork and main stem of the La Moine River, approximately 15 miles south of the Mississippi River and Iowa/Illinois border. The project area continues through agricultural and forested land, ending downstream of Beardstown at the confluence with the Illinois River. The project area covers nearly 851 square miles, and includes land within Adams, Brown, Fulton, Hancock, McDonough and Schuyler Counties.

2.1 Jurisdictions and Population

Counties with land in the watershed include Adams, Brown, Fulton, Hancock, McDonough and Schuyler. A portion of the city of Macomb is located in the headwaters of the watershed and the city itself accounts for approximately two-thirds of the population of McDonough County. The remaining developed areas are small towns (e.g., Camden and Ripley). County populations are area weighted (i.e., takes into account the proportional area) to the watershed in Table 2. To improve population estimates, the population of McDonough County was adjusted to include only the proportion of the city of Macomb within the watershed.

Table 2. Area weighted county populations within project area

County	2000	2010	Percent Change
Adams	4,404	4,328	-2%
Brown	2,878	2,873	0%
Fulton	41	40	-2%
Hancock	3,917	3,719	-5%
McDonough	9,142	8,815	-4%
Schuyler	3,990	4,187	5%
TOTAL	***24,372***	***23,962***	***-2%***

Source: U.S. Census Bureau

2.2 Climate

Climate data are available from the National Oceanic and Atmospheric Administration (NOAA) Global Historical Climatology Network Database (GHCND); Station USC00117551 is located in Rushville, IL in the southern portion of the La Moine/Missouri Creek watershed (see Figure 1) and was used for analysis. In general, the climate of the region is continental with hot, humid summers and cold winters. Table 3 contains historical temperature data collected at the Rushville climate station. From 1893 to 2014 the average high winter temperature in Rushville was 37.3 °F and the average high summer temperature was 85.4 °F.

From 1893 to 2014, the annual average precipitation in Rushville was approximately 36.4 inches, including approximately 19.5 inches of snowfall. In general, larger volumes of precipitation tend to occur between the months of April and September.

Table 3. Climate summary at Rushville (1893-2014)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average High ºF	34	39	51	64	74	83	88	86	79	67	52	39
Average Low ºF	17	21	31	42	52	61	65	63	55	44	32	22
Mean Temperature ºF	26	30	41	53	63	72	76	74	67	56	42	30
Average Precipitation (in)	1.8	1.5	2.8	3.8	4.3	4.1	3.6	3.5	3.8	2.8	2.4	2.0
Average snow fall (in)	5.3	4.6	3.3	0.7	0.0	0.0	0.0	0.0	0.0	0.1	1.1	4.4

Source: NOAA GHCND

2.3 Land Use and Land Cover

Land use in the watershed is heavily influenced by agriculture (Figure 2). There is a small amount of urban area surrounding the town of Rushville and other small towns in the watershed, but outside of agriculture the remainder of the watershed is mostly forested. Specific land use across the watershed includes agriculture – cultivated crops and pasture/hay (approximately 66 percent), forest (approximately 27 percent), and urban (approximately 5 percent). Corn and soybeans are the primary crops grown in the watershed and account for 26 and 21 percent of the total watershed area, respectively according to the 2013 USDA Cropland Data Layer. Forest is prevalent near streams where steep valley walls preclude row crop agricultural activities. Table 4 presents area and percent by land cover type. Table 5 summarizes land covers that are contributing to each of the impaired segments. Both tables were derived from the 2011 National Land Cover Database (Multi-Resolution Land Characteristics Consortium 2015).

Table 4. Watershed land cover summary

Land Use / Land Cover Category	Acreage	Percentage
Cultivated Crops	282,540	52.0%
Deciduous Forest	148,059	27.2%
Hay/Pasture	73,812	13.6%
Developed, Low Intensity	15,620	2.9%
Developed, Open Space	10,493	1.9%
Woody Wetlands	6,660	1.2%
Developed, Medium Intensity	2,830	0.5%
Open Water	1,579	0.3%
Herbaceous	735	0.1%
Developed, High Intensity	527	0.1%
Barren Land	310	0.1%
Shrub/Scrub	272	0.1%
Emergent Herbaceous Wetlands	240	0.0%
Evergreen Forest	7	0.0%
Total	**543,684**	**100.0%**

Source: 2011 National Land Cover Database (Multi-Resolution Land Characteristics Consortium 2015)

Table 5. Land cover by impaired segment

Watershed	Segment ID	Watershed Area (square miles)	Cultivated Crops	Pasture /Hay	Developed	Forest	Grassland/ Herbaceous/ Shrub/Scrub	Barren Land	Wetlands and Water
			%						
La Moine River	IL_DG-01	851	51.9	13.6	5.4	27.2	0.2	0.1	1.6
La Moine River	IL_DG-04	396	60.1	12.9	5.7	19.8	0.2	0.1	1.2
Missouri Creek	IL_DGD-01	92	35.8	20.3	4.0	38.9	0.1	0	0.9
Little Missouri Creek	IL_DGDA-01	37	35.9	16.5	4.2	42.6	0.2	0	0.6

Source: 2011 National Land Cover Database (Multi-Resolution Land Characteristics Consortium 2015)

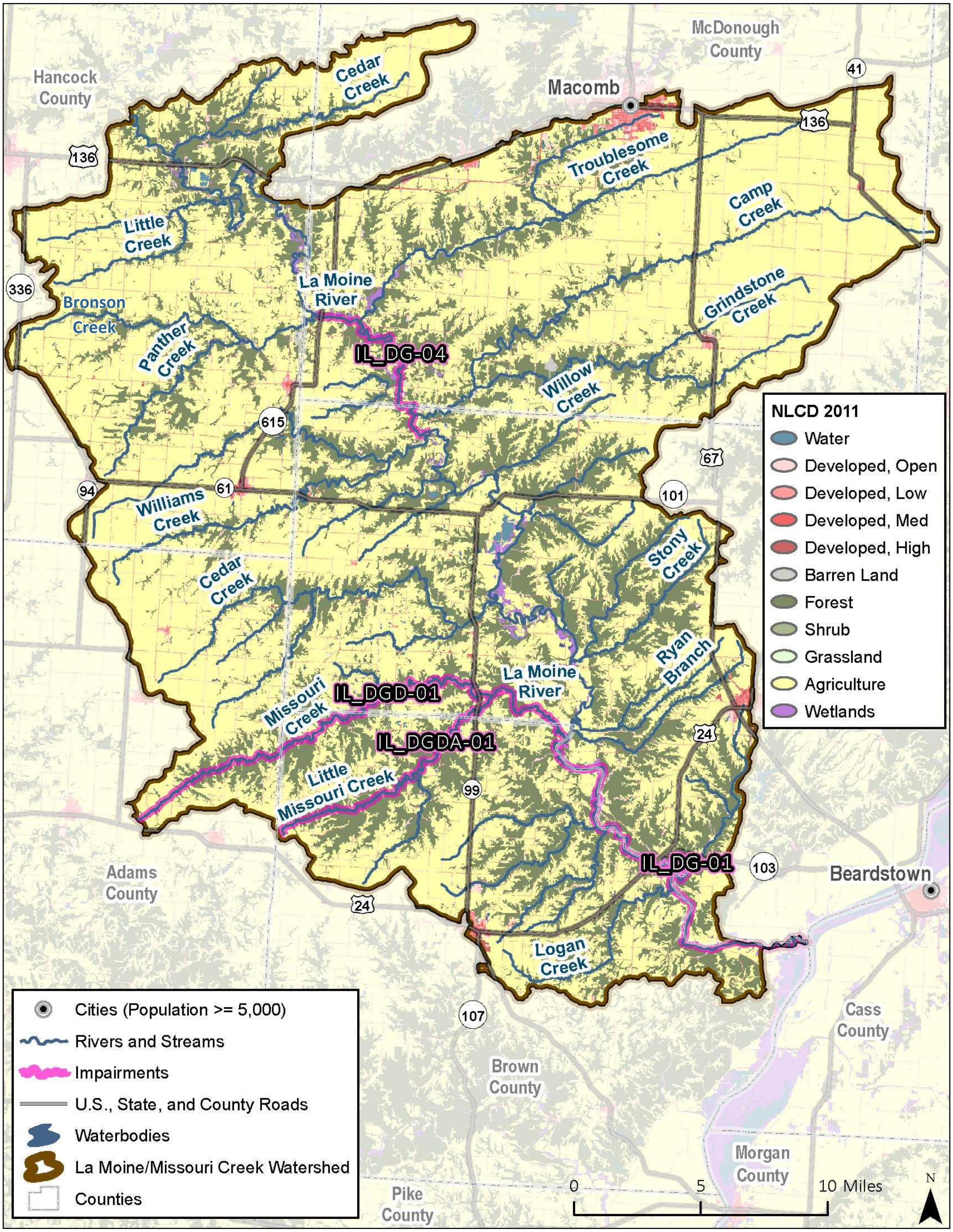

Figure 2. La Moine/Missouri Creek watershed land cover (2011 National Land Cover Database).

2.4 Topography

Topography is an important factor in watershed management because stream types, precipitation, and soil types can vary dramatically by slope and elevation. The La Moine/Missouri Creek watershed varies in elevation from 425 to 810 feet (Figure 3) based on a 30-meter digital elevation model. The La Moine River water elevation varies from 534 feet to 428 feet and is 86 miles long in the La Moine/Missouri Creek watershed, resulting in an average stream gradient of 1.2 feet per mile. The watershed consists of rolling hills with steep-walled wooded valleys (IDNR 2005).

2.5 Soils

The National Cooperative Soil Survey publishes soil surveys for each county within the U.S. These soil surveys contain predictions of soil behavior for selected land uses. The surveys also highlight limitations and hazards inherent in the soil, general improvements needed to overcome the limitations, and the impact of selected land uses on the environment. The soil surveys are designed for many different uses, including land use planning, the identification of special practices needed to ensure proper performance, and mapping of hydrologic soil groups (HSGs) (NRCS 2007).

HSGs refer to the grouping of soils according to their runoff potential. Soil properties that influence the HSGs include depth to seasonal high water table, infiltration rate and permeability after prolonged wetting, and depth to slow permeable layer. There are four groups of HSGs: Group A, B, C, and Group D. Table 6 describes those HSGs found in the La Moine/Missouri Creek watershed area. Figure 4 and Table 7 summarizes the composition of HSGs per watershed.

Table 6. Hydrologic soil group descriptions (NRCS 2007)

HSG	Group Description
A	Sand, loamy sand or sandy loam types of soils. Low runoff potential and high infiltration rates even when thoroughly wetted. Consist chiefly of deep, well to excessively drained sands or gravels with a high rate of water transmission.
B	Silt loam or loam. Moderate infiltration rates when thoroughly wetted. Consist chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.
C	Soils are sandy clay loam. Low infiltration rates when thoroughly wetted. Consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.
D	Soils are clay loam, silty clay loam, sandy clay, silty clay or clay. Group D has the highest runoff potential. Low infiltration rates when thoroughly wetted. Consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.
A-C/D	Dual Hydrologic Soil Groups. Certain wet soils are placed in group D based solely on the presence of a water table within 24 inches of the surface even though the saturated hydraulic conductivity may be favorable for water transmission. If these soils can be adequately drained, then they are assigned to dual hydrologic soil groups (A/D, B/D, and C/D) based on their saturated hydraulic conductivity and the water table depth when drained. The first letter applies to the drained condition and the second to the undrained condition.

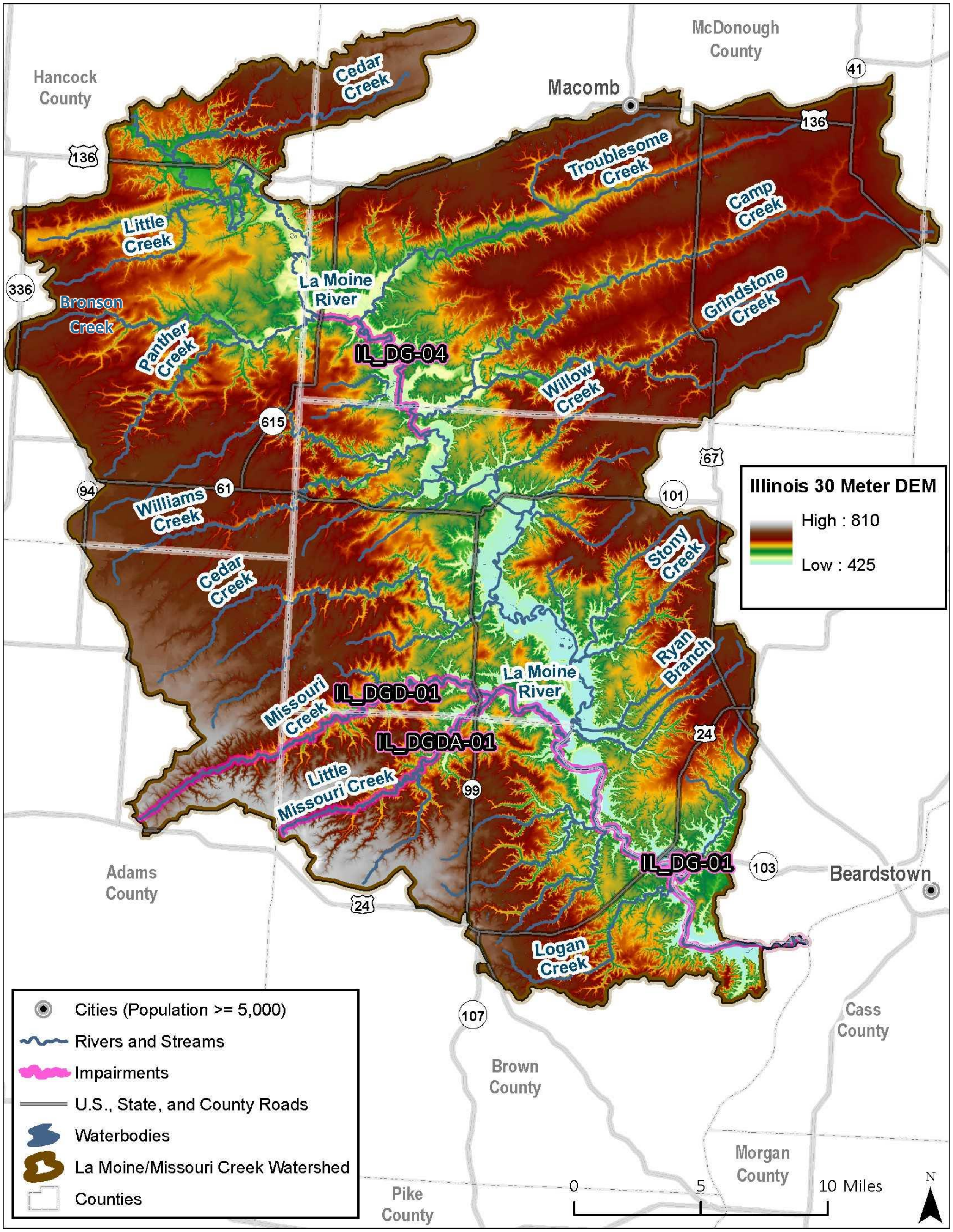

Figure 3. La Moine/Missouri Creek watershed land elevations based on 30-meter digital elevation model (ISGS 2003).

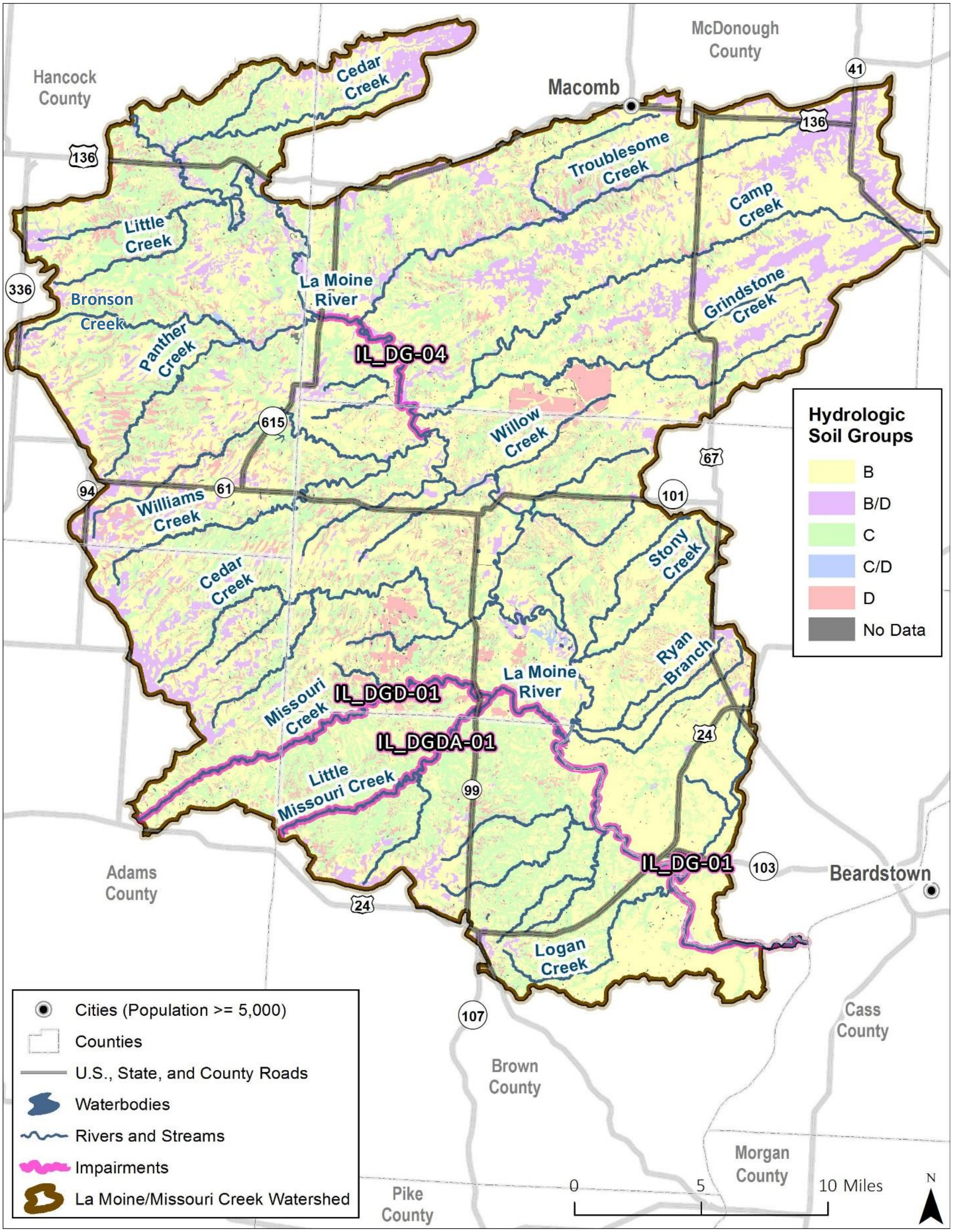

Figure 4. La Moine/Missouri Creek watershed hydrologic soil groups (Soil Surveys for Adams, Brown, Fulton, Hancock, McDonough and Schuyler Counties, Illinois; NRCS SSURGO Database 2011).

Table 7. Percent composition of hydrologic soil group per watershed

Watershed	Segment	A/D	B	B/D	C	C/D	D	No Data
		%						
La Moine River	IL_DG-01	0	54.5	9.9	27.6	0.2	7.4	0.4
La Moine River	IL_DG-04	0	53	15	25	0.2	6.5	0.3
Missouri Creek	IL_DGD-01	0	51	12.8	28.6	0.2	7.1	0.3
Little Missouri Creek	IL_DGDA-01	0	36	5.8	50.7	0	7.4	0.1

Source: NRCS SSURGO Database 2011

A commonly used soil attribute is the K-factor. The K-factor:

> *Indicates the susceptibility of a soil to sheet and rill erosion by water. (The K-factor) is one of six factors used in the Universal Soil Loss Equation to predict the average annual rate of soil loss by sheet and rill erosion. Losses are expressed in tons per acre per year. These estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.02 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water (NRCS 2005).*

The distribution of K-factor values in the La Moine/Missouri Creek watershed range from 0.02 to 0.55, with an average value of 0.38 (Figure 5).

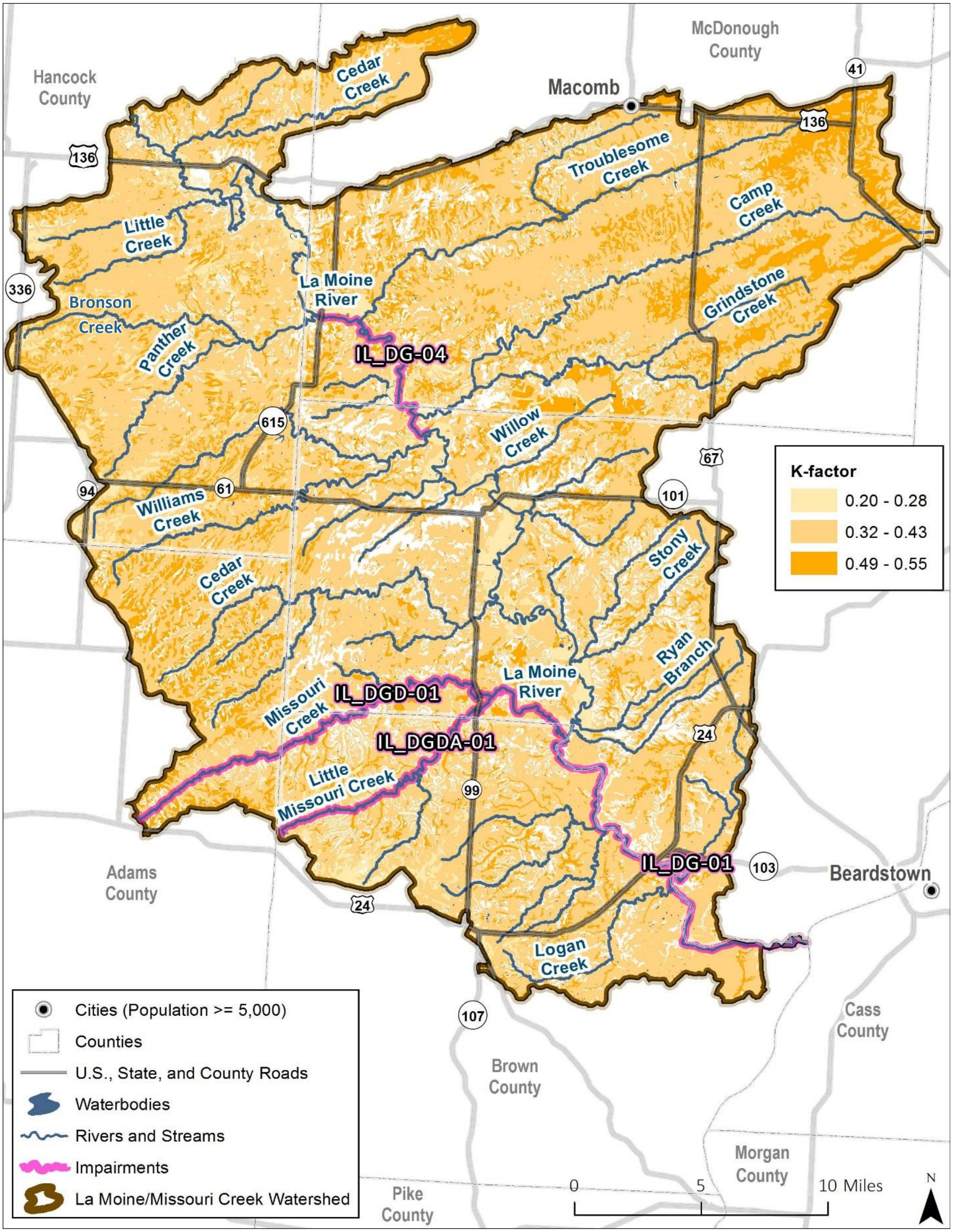

Figure 5. La Moine/Missouri Creek watershed soil K-factor values (Soil Surveys for Adams, Brown, Fulton, Hancock, McDonough and Schuyler Counties, Illinois; NRCS SSURGO Database 2011).

2.6 Hydrology and Water Quality

Hydrology plays an important role in evaluating water quality. The hydrology of the La Moine/Missouri Creek watershed is driven by local climate conditions and the landscape. The U.S. Geological Survey (USGS) has been collecting flow and water quality data in this watershed since the 1920s; Illinois EPA has been collecting water quality data since 1999.

2.6.1 USGS Flow Data

The USGS has monitored flow at several locations in the watershed (Table 8 and Figure 6). The daily average, peak history, and monthly flow data show the inherent variability associated with hydrology. Flow duration curves provide a way to address that variability and flow related water quality patterns. Duration curves describe the percentage of time during which specified flows are equaled or exceeded. Flow duration analysis looks at the cumulative frequency of historic flow data over a specified period, based on measurements taken at uniform intervals (e.g., daily average or 15-minute instantaneous). Duration analysis results in a curve that relates flow values to the percent of time those values have been met or exceeded. Low flows are exceeded a majority of the time, whereas floods are exceeded infrequently. Flow duration curves for the active USGS gages are presented in Figure 7.

Table 8. USGS stream gages within project area

Gage ID	Watershed Area *(mi.^{2})*	Location	Period of Record	Impaired Segment
05584500	**655**	**La Moine River at Colmar, IL**	**1944-2015**	**IL_DG-04**
05584680	35.5	Grindstone Creek near Industry, IL	1979-1981	-
05584682	0.17	Grindstone Creek Trib No. 2 near Doddsville, IL	1981-1983	-
05584683	0.22	Grindstone Creek Tributary near Doddsville, IL	1980-1981	-
05584685	46.5	Grindstone Creek near Birmingham, IL	1979-1981	-
05584950	2.16	West Creek at Mount Sterling, IL	1961-1972	-
05585000	**1,293**	**La Moine River at Ripley, IL**	**1921-2015**	**IL_DG-01**

BOLD – indicates active USGS gage

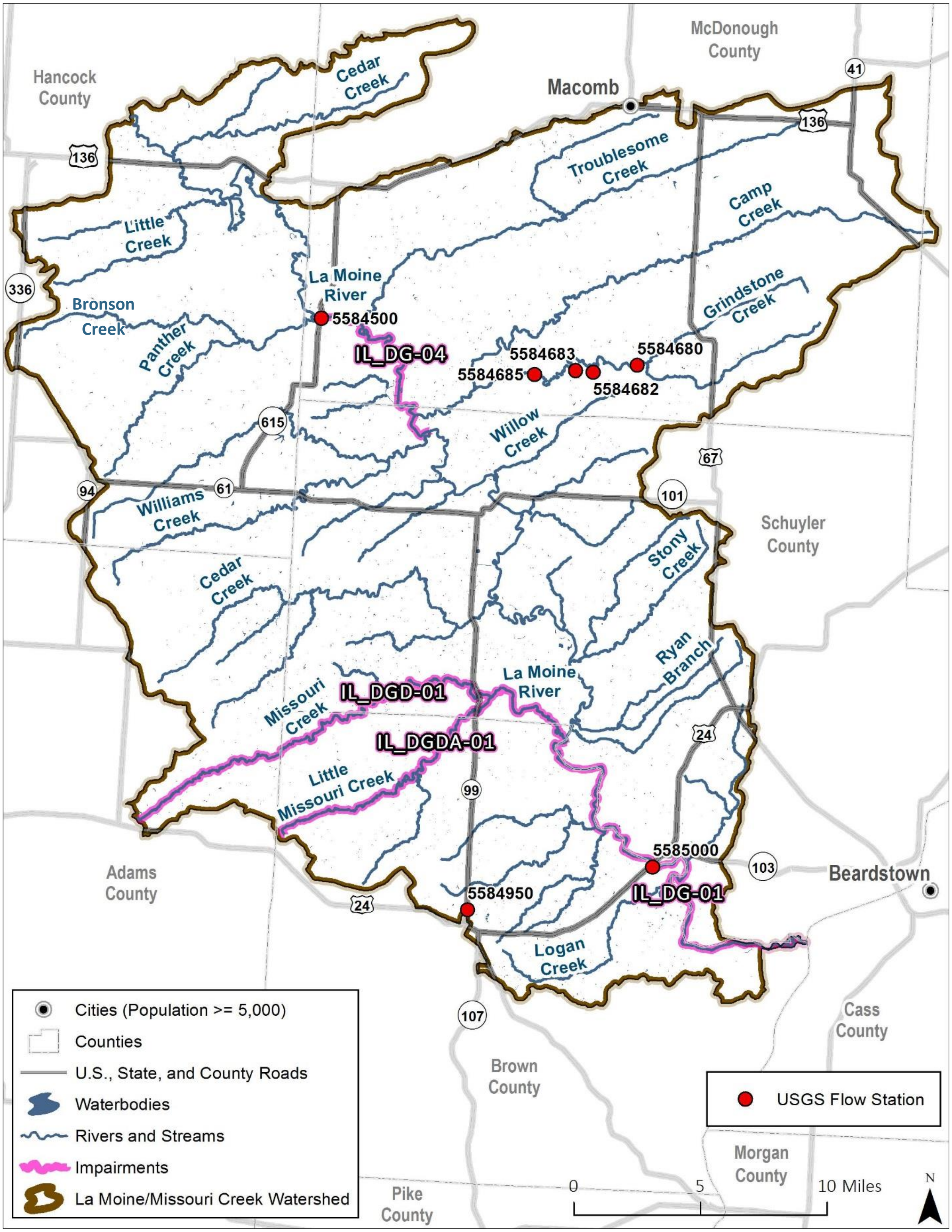

Figure 6. USGS stream gages within watershed.

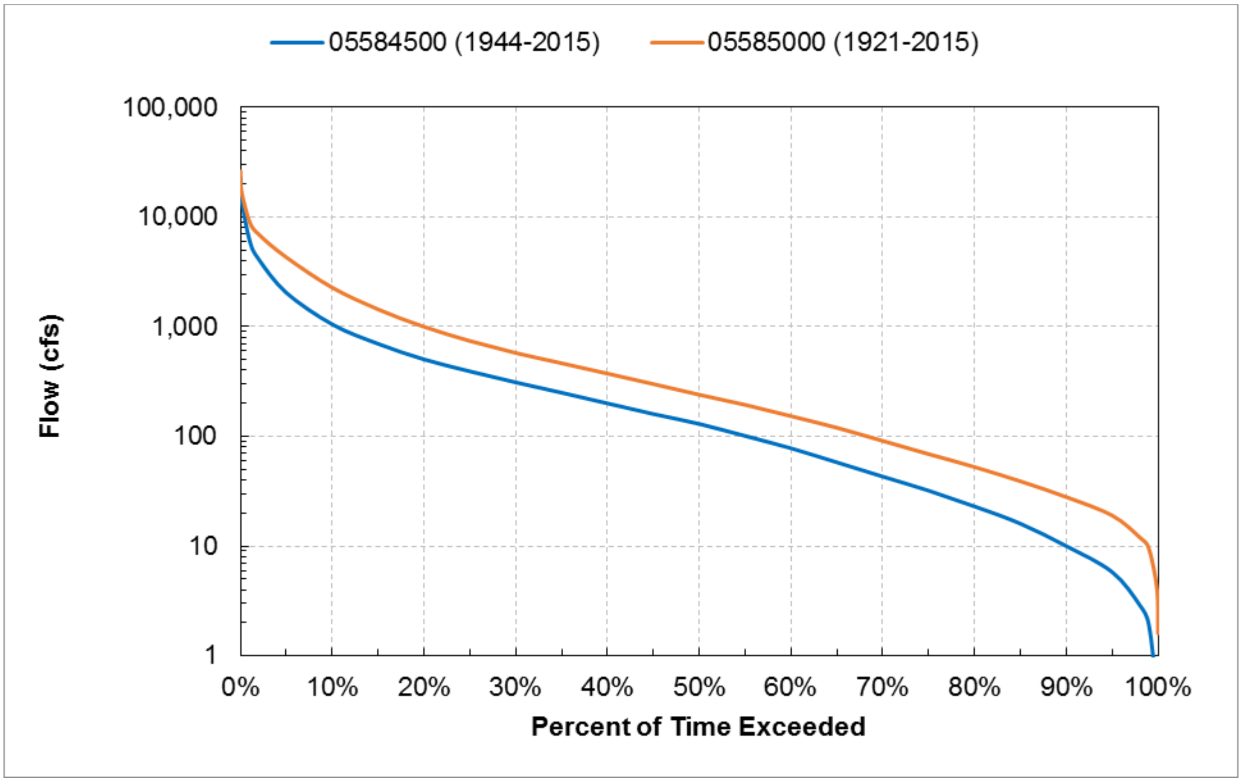

Figure 7. Flow duration curves for the active USGS gages in the La Moine/Missouri Creek watershed.

An evaluation of annual flow at USGS gages 05584500 and 05585000 on the La Moine River from 1944 to 2015, and 1921 to 2015, respectively, show that annual flow in 2014 was nearly at the median. Flow at USGS gages 05584500 and 0558500 are plotted with precipitation from the NOAA GHCND Station USC00117551 (Rushville) for 2014 in Figure 8.

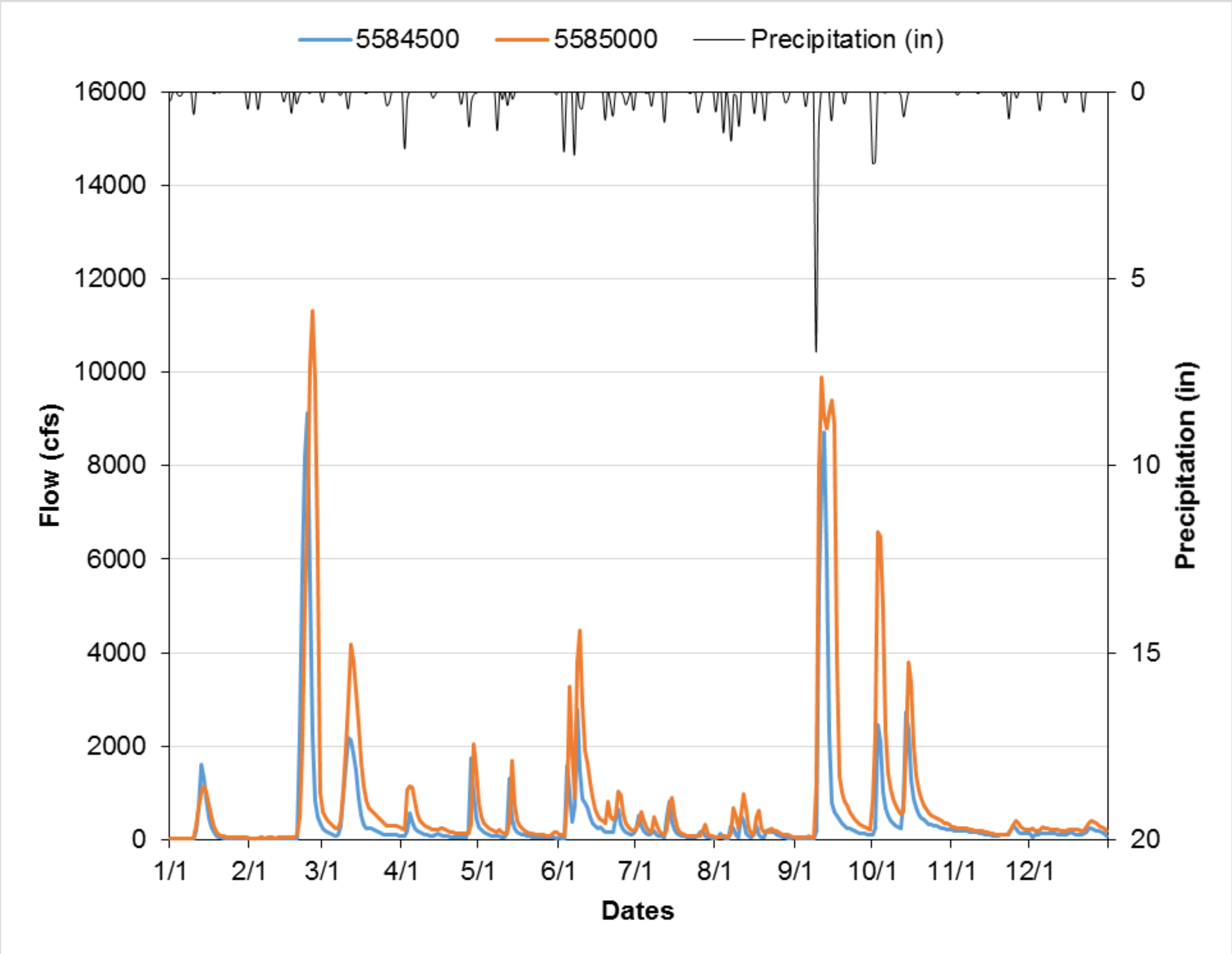

Figure 8. Daily flow in the La Moine River with daily precipitation at Rushville (USC00117551), 2014.

2.6.2 Illinois EPA Water Quality Monitoring

Routine water quality monitoring is a key part of the Illinois EPA assessment program. The goals of Illinois EPA surface water monitoring programs are to determine whether designated uses are supported, identify causes of pollution (toxics, nutrients, sedimentation) and sources (point or nonpoint) of surface water impairments, determine the overall effectiveness of pollution control programs, and identify long term resource quality trends. Illinois EPA has operated a widespread, active long-term monitoring network in Illinois since 1977, known as the Ambient Water Quality Monitoring Network (AWQMN). Table 9 includes all of the chemical parameters that are collected and analyzed as part of the AWQMN program. In addition, dissolved oxygen, specific conductivity, temperature, and pH are measured in the field at the time of sample collection. The AWQMN is utilized by the IEPA to provide baseline water quality information, to characterize and define trends in the physical, chemical and biological conditions of the state’s waters, to identify new or existing water quality problems, and to act as a triggering mechanism for special studies or other appropriate actions.

Table 9. Summary of Illinois EPA laboratory methods for parameters in the AWQMN

Parameter	Sample Container	Chemical/Thermal Preservation	Method of Analysis	Units of Measure	Holding Time
Fecal Coliform Bacteria	120 ml plastic	Contains sodium thiosulfate; Cool, < 6 °C	SM 9222D	no./100ml	24 hours monitoring
Total Suspended Solids (TSS)	500 ml PE	Cool, < 6 °C	SM 2540D	mg/L	7 days
Total Nitrate+Nitrite-N (NO3+NO2-N)	250/500 ml HDPE	Contains sulfuric acid; Cool, < 6 °C	U.S. EPA 353.2	mg/L	28 days
Ammonia-N (NH3+NH4-N)	250/500 ml HDPE	Contains sulfuric acid; Cool, < 6 °C	U.S. EPA 350.1	mg/L	28 days
Pesticides	1 gallon amber glass	Cool, < 6 °C	U.S. EPA 8081	µg/l	7 days collection-prep; 40 days prep-analysis
Total Organic Carbon (TOC)	Three 40-ml amber vials	Contains phosphoric acid; Cool, < 6 °C	SM 5310C	mg/L	28 days
Chlorophyll	1 L plastic amber	Contains magnesium carbonate; filter in field; freeze filter, -20 °C	SM 10200H	µg/l	28 days collection-prep; 365 days prep-analysis
Total Kjeldahl Nitrogen (TKN)	250/500 ml HDPE	Contains sulfuric acid; Cool, < 6 °C	U.S. EPA 351.2	mg/L	28 days
Total Phosphorus	250/500 ml HDPE	Contains sulfuric acid; Cool, < 6 °C	U.S. EPA 365.1	mg/L	28 days
Dissolved Phosphorus	250 ml HDPE	Contains sulfuric acid; filter in field; Cool, < 6 °C	U.S. EPA 365.1	mg/L	28 days
Total ICP*:* (Pb, Cu, Fe, Mn, Cd, Cr, Mg, Zn, K, Ba, Be, Co, Ni, Sr, Ca, Na, Al, B, Ag, V, Se, As)	250 ml PE	Preserved in lab with nitric acid; no thermal preservation required	U.S. EPA 200.7, 200.8	µg/l	6 months
Dissolved ICP*:* (Pb, Cu, Fe, Mn, Cd, Cr, Mg, Zn, K, Ba, Be, Co, Ni, Sr, Ca, Na, Al, B, Ag, V, Se, As)	250 ml PE	Preserved in lab with nitric acid; filter in field; no thermal preservation required	U.S. EPA 200.7, 200.8	µg/l	6 months
Sulfate (SO4)	500 ml PE	Cool, < 6 °C	U.S. EPA 375.2	mg/L	28 days
Total Dissolved Solids (TDS)	500 ml PE	Cool, < 6 °C	SM 2540C	mg/L	7 days
Cyanide	250 ml PE	Contains sodium hydroxide; Cool, < 6 °C	U.S. EPA 335.4	mg/L	14 days
Chloride	500 ml PE	No thermal preservation required	SM 4500Cl-E	mg/L	28 days
Total Alkalinity	500 ml PE	Cool, < 6 °C	EPA 310.2	mg/L	14 days
Total Mercury	60 ml glass vial	Preserved in lab with nitric acid; no thermal preservation required	U.S. EPA 245.1/7470	µg/l	28 days
Total Hardness (calculated)	250 ml PE	Preserved in lab with nitric acid; no thermal preservation required	SM 2340B	mg/L	6 months
Fluoride	500 ml PE	No thermal preservation required	SM 4500F-C	mg/L	28 days
Phenol	250 ml glass	Contains sulfuric acid; Cool, < 6 °C	U.S. EPA 420.4	µg/l	28 days

Notes: Dissolved metals and phosphorus are filtered through a 0.45 µm nitrocellulose membrane filter.

**General use* water quality standards based on Section 302(subpart B) of Title 35*:* Subtitle C*:* Chapter I, Illinois Pollution Control Board. June 1998. H = hardness dependent acute and chronic standards. a = acute, c = chronic

Note that sample containers have changed somewhat over time. For example, the quart polyethylene bottle was replaced by a 500 ml bottle because the smaller bottle contained enough material for analysis and was less expensive to ship to the laboratory.

Additional uses of the data collected by the Illinois EPA through the AWQMN program include the review of existing water quality standards and establishment of water quality based effluent limits for NPDES permits. The AWQMN is integrated with other Illinois EPA chemical and biological stream monitoring programs including Intensive River Basin Surveys, Facility –Related Stream Surveys, Fish Contaminant Monitoring, Toxicity Testing Program and Pesticide Monitoring Subnetwork which are more regionally based (specific watersheds or point source receiving stream) and cover a shorter span of time (e.g., one year) to evaluate compliance with water quality standards and determine designated use support. Information from these programs is compiled by Illinois EPA into the Illinois Integrated Water Quality Report as required by the Federal Clean Water Act.

Within the La Moine/Missouri Creek watershed, data were found for numerous stations that are part of AWQMN (Figure 9 and Table 10). Parameters sampled on the streams include field measurements (water temperature) as well as those that require lab analyses (e.g., fecal coliform, nutrients, and total suspended solids). Many sites have historical data that are greater than 10 years old. Data were obtained directly from Illinois EPA.

Additional water quality data are also available at two USGS stations (Figure 6 and Table 10). Parameters sampled include suspended and dissolved solids, nutrients, dissolved oxygen, turbidity, fecal coliform, and metals.

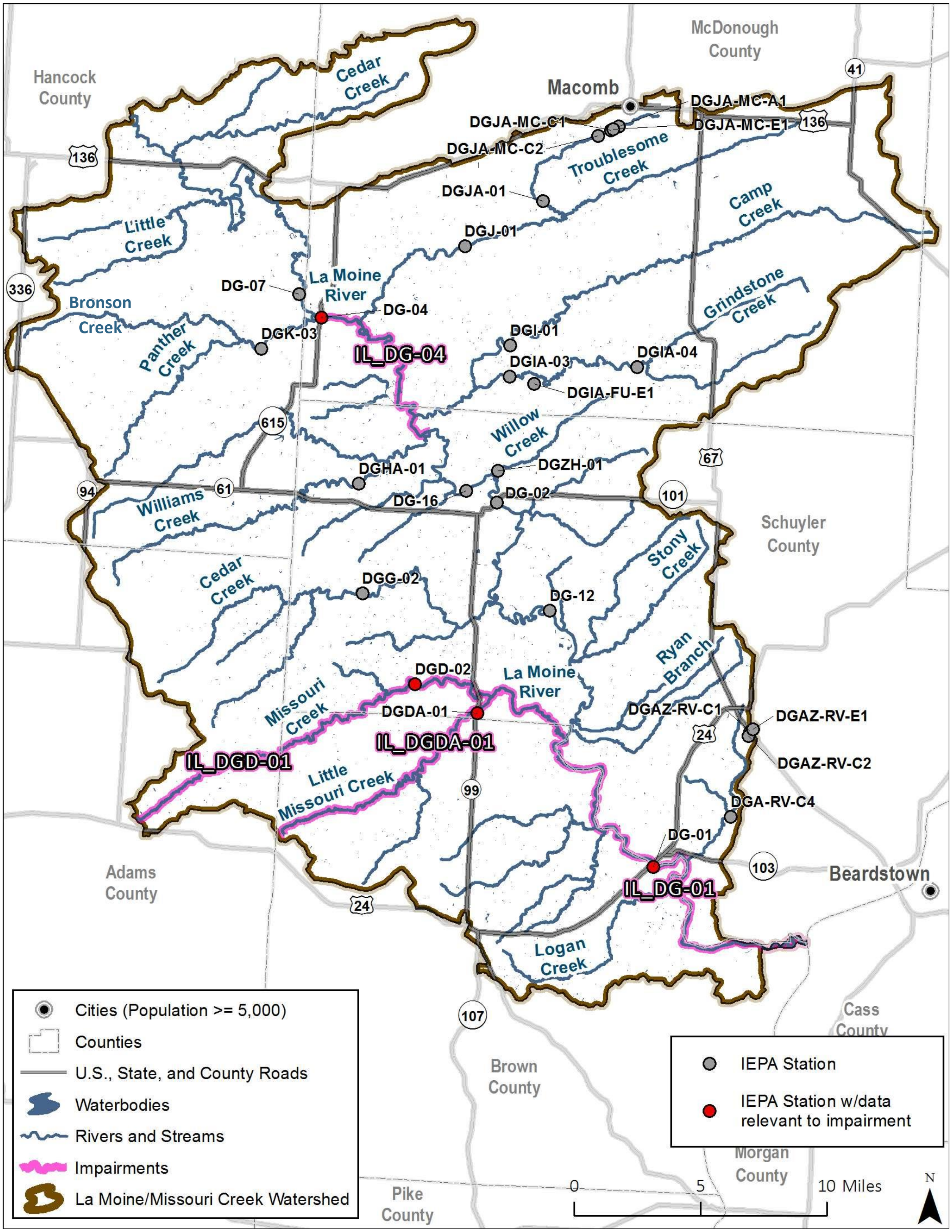

Figure 9. Illinois EPA water quality sampling sites within watershed.

Table 10. La Moine/Missouri Creek watershed water quality data

AWQMN Sites	USGS Gage	Waterbody	Location	Period of Record
DG-01	**05585000**	La Moine River	Old US 24 (1500E) Br., 0.2 Mi. E of US 24 and 0.4 Mi. NE of Ripley	*1964-1997*, *1999*-2013
DG-02	--		RT 101 Br. E Brooklyn	*2002*, 2012
DG-04	**05584500**		RT 61 Br., 0.9 Mi. S of St. Marys Rd. (1000N) and 1.2 Mi. SW of Colmar	*1957*-2013
DG-07	--		CO Rd. 6 Br. 1.25 Mi. W Colmar	2007, 2011-2012
DG-12	--		Greenwell Rd. Br. 3 Mi. NE Camden	*2002*
DG-16	--		CO Rd. 660E Br. 1 Mi. N and 0.6 Mi. W of Brooklyn	2007, 2012
DGA-RV-C4	--	Town Branch	West Branch Rd. Br. 4 Mi. S of Rushville and 4 Mi. downstream Rushville STP	2007
DGAZ-RV-C1	--	Rushville STP Trib	US 67 Br. 300 yds. downstream Rushville STP	2007
DGAZ-RV-C2	--		Parkview Rd., 0.75 Mi. S of Rushville and 0.4 Mi downstream Rushville STP	2007
DGAZ-RV-E1	--		Rushville STP, S Liberty St. (CR 1), 0.5 Mi. S of Rushville	2007
DGD-02	--	Missouri Creek	3 Mi. SW Camden dirt road	*2002*, 2007, 2012
DGDA-01	--	Little Missouri Creek	IL RT 99 Br. 3 Mi. S Camden	*2002*, 2012
DGG-02	--	Cedar Creek - South	1.25 Mi. S Huntsville TWP Rd. Br.	*2002*, 2007, 2012
DGHA-01	--	Williams Creek	5.5 Mi. E Augusta at dirt rd. ford	*2002*, 2007, 2012
DGI-01	--	Camp Creek	3.5 Mi S Fandon TWP Rd. Br.	*2002-2003*, 2007, 2012
DGIA-03	--	Grindstone Creek	4.5 Mi S Fandon CO Rd. #8	*2002-2003*, 2007, 2012
DGIA-04	05584680		3 Mi. SW Industry TWP Rd.	*1979-1981*, *2003*
--	05584682		Grindstone Creek Trib No. 2 near Doddsville, IL	*1982-1983*
--	05584683		Grindstone Creek Tributary near Doddsville, IL	*1981*
--	05584685		Grindstone Creek near Birmingham, IL	*1979-1981*
DGIA-FU-E1	--		Outfall #19 at mine near Industry	*2003*
DGJ-01	--	Troublesome Creek	3 Mi. S Colchester	*2002*, 2007, 2012
DGJA-01	--	Killjordan Creek	4 Mi. SW Macomb CO Rd. #18	2012
DGJA-MC-A1	--		Near corner W Grant St. and S Garfield St., 0.4 Mi. upstream of Macomb STP	2007
DGJA-MC-C1	--		Cherokee Rd. Br. 100 yds. downstream of Macomb STP	2007
DGJA-MC-C2	--		SW of Macomb and 0.5 Mi. downstream of Macomb STP	2007
DGJA-MC-E1	--		Macomb STP, 901 W Grant St. SW edge of Macomb	2007
DGK-03	--	Bronson Creek	CO Rd. 2900E 1.5 Mi. NW of Plymouth	*2002*
DGZH-01	--	Willow Creek	2 Mi. N Brooklyn	*2003*

Italics – Data are greater than 10 years old
STP – Sewage treatment plant
BOLD – indicates active USGS gage

3. Watershed Source Assessment

Source assessments are an important component of water quality management plans and TMDL development. This section provides a summary of potential watershed-wide sources that contribute listed pollutants to the La Moine/Missouri Creek watershed.

3.1 Pollutants of Concern

Pollutants of concern evaluated within this source assessment include fecal coliform, manganese, and oxygen demanding substances. These pollutants can originate from an array of sources including point and nonpoint sources. Point sources typically discharge at a specific location from pipes, outfalls, and conveyance channels. Nonpoint sources are diffuse sources that have multiple routes of entry into surface waters, particularly overland runoff. This section provides a summary of potential point and nonpoint sources that contribute pollutants to the impaired waterbodies.

3.2 Point Sources

Point source pollution is defined by the Federal Clean Water Act (CWA) §502(14) as:

> *"any discernible, confined and discrete conveyance, including any ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation [CAFO], or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agriculture storm water discharges and return flow from irrigated agriculture."*

Point sources in the watershed include facilities such as municipal wastewater treatment plants (WWTPs), industrial facilities, and concentrated animal feeding operations (CAFO). Stormwater can also be regulated including municipal separate storm sewer systems, however there are no regulated municipal separate storm sewer systems in the watershed. Under the CWA, all point sources are regulated under the NPDES program. NPDES permit holders in the watershed are discussed below.

3.2.1 NPDES Facilities (Non-CAFO)

A municipality, industry, or operation must apply for an NPDES permit if an activity at that facility discharges wastewater to surface water. Examples of NPDES facilities within the study area include municipal and industrial wastewater treatment plants. Bacteria and oxygen demanding substances (e.g., nutrients, biochemical oxygen demand) can be found in these discharges.

There are 11 individual NPDES permitted facilities within the watershed. Table 11 and Figure 10 include each NPDES permitted facility within the watershed. Average and maximum design flows and downstream impairments are included in the facility summaries. Six facilities have disinfection exemptions in the watershed which allow a facility to discharge wastewater without disinfection. Facilities with disinfection exemptions may be required to provide IEPA with updated information to demonstrate compliance with these requirements and facilities directly discharging into a fecal coliform impaired segment may have their disinfection exemption reviewed through future NPDES permitting actions.

Three facilities (Mount Sterling, Colchester, and Macomb) also have special conditions included within NPDES permits that prohibit the discharge of sanitary sewer overflows (SSOs). A SSO can spill raw sewage into basements or out of manholes prior to it reaching a sewage treatment plant.

Table 11. Individual NPDES permitted facilities

IL Permit ID	Facility Name	Facility Type	Receiving Water	Downstream Impairment	Average Design Flow (MGD)	Maximum Design Flow (MGD)	Disinfection Exemption
IL0022411	MT STERLING, CITY OF	STP	UNNAMED TRIB TO WEST CREEK	DG-01	0.366	0.54	Yes
IL0027570	AUGUSTA STP	STP	UNNAMED TRIB OF WILLIAMS CREEK	DG-04, DG-01	0.093	0.2325	Yes
IL0028177	COLCHESTER, CITY OF	STP	UNNAMED TRIB OF EAST FORK OF LAMOINE RIVER	DG-04, DG-01	0.17	0.47	Yes
IL0029688	MACOMB, CITY OF	STP	KILJORDAN CREEK	DG-04, DG-01	3.0	7.5	Yes
IL0042153	PLYMOUTH, VILLAGE OF	STP	UNNAMED TRIB TO BRONSON CREEK	DG-04, DG-01	0.06	0.3	Yes
IL0054267	COUNTRY AIRE ESTATES MHP	STP	UNNAMED TRIB TO KILLJORDAN CREEK	DG-04, DG-01	0.0126	0.0315	Yes
ILG580048	INDUSTRY, VILLAGE OF	STP	GRINDSTONE CREEK	DG-04, DG-01	0.075	0.1875	Yes
ILG640235	CLAYTON CAMP POINT WATER COMMISSION	Public water supply	BRANCH OF LOGAN CREEK	DG-01	*NA*	*NA*	--[a]
ILG840080	CENTRAL STONE CO	Non-coal mining	LAMOINE RIVER	DG-04, DG-01	*NA*	*NA*	--[a]
ILG840189	CENTRAL STONE COMPANY	Non-coal mining	WATERS OF THE STATE	DG-04, DG-01	*NA*	*NA*	--[a]
ILG840208	R L O'NEAL AND SONS INC	Non-coal mining	UNNAMED TRIB TO BRONSON CREEK	DG-04, DG-01	*NA*	*NA*	--[a]

MGD – Million gallons per day
STP – Sewage treatment plant
a. These facilities are not expected to contribute fecal coliform.

3.2.2 CAFOs

The area that produces manure, litter, or processed wastewater as the result of CAFOs is considered a point source that is regulated through the NPDES Program. In Illinois, the CAFO program is administered by the Illinois EPA through general permit number ILA01 (refer to the following Web site for more details: http://www.epa.state.il.us/water/cafo/). The federal regulations for all CAFOs can be found in 40 CFR Parts 9, 122, and 412.U.S. EPA requires that CAFOs receive a WLA as part of the TMDL development process. The WLA is typically set at zero for all pollutants. There is one CAFO in the La Moine/Missouri Creek watershed: Pinnacle Genetics (ILA010002). The facility is located within the Troublesome Creek watershed. Troublesome Creek drains to impaired segment DG-04 of the La Moine River.

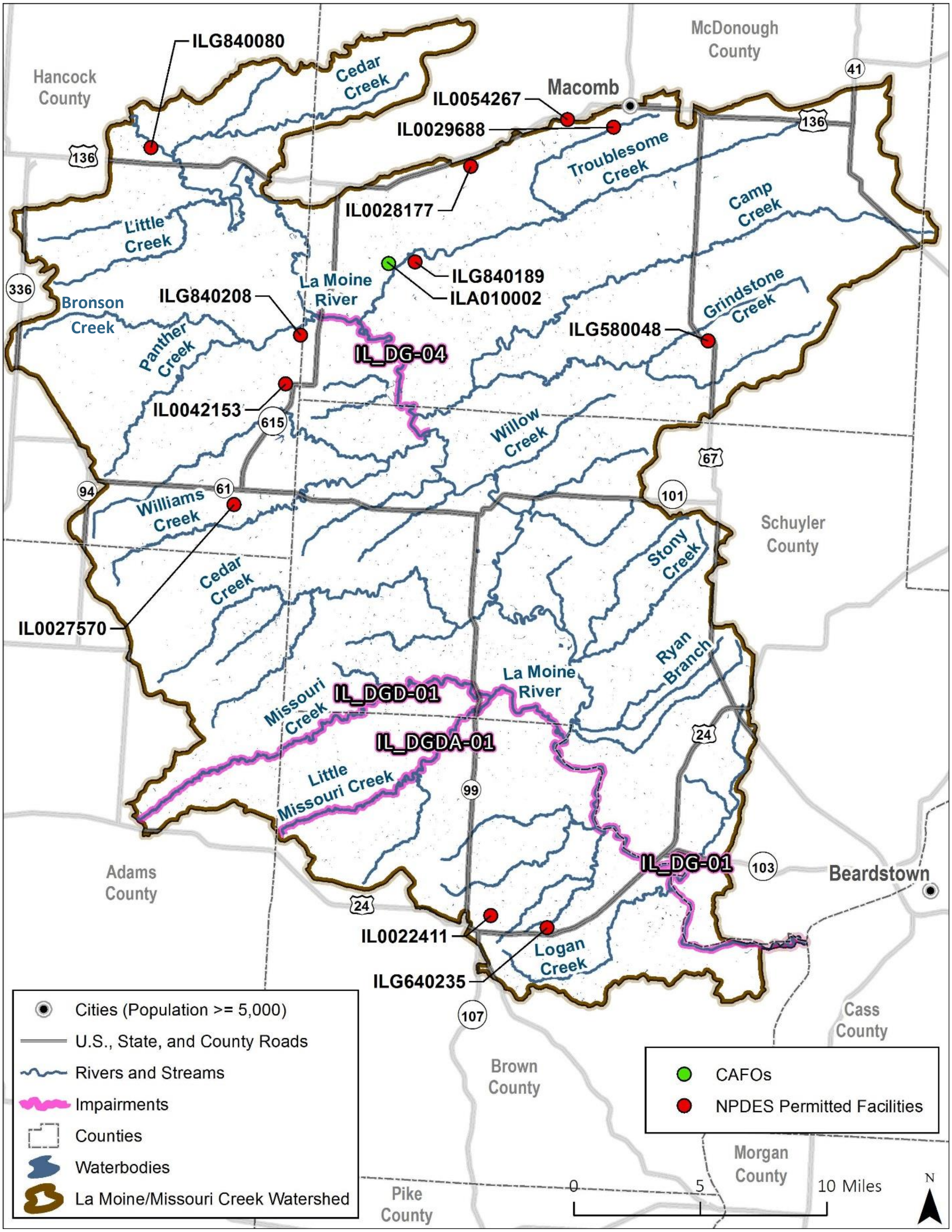

Figure 10. Point sources within watershed.

3.3 Nonpoint Sources

The term nonpoint source pollution is defined as any source of pollution that does not meet the legal definition of point sources. Nonpoint source pollution typically results from overland stormwater runoff that is diffuse in origin, as well as background conditions. With agricultural practices such as crop cultivation (52 percent) and pasture/hay (14 percent) covering an estimated 66 percent of the project area, nonpoint source pollution may contribute a significant amount of the total pollutant load. In addition to runoff and erosion, significant nonpoint sources also include septic systems, livestock, and agricultural tile drainage. There is a history of coal mining in the watershed, primarily in McDonough, Schuyler, and Brown counties. Historical strip mining and underground mining activities in the watershed have resulted in erosion and acid runoff. To limit ongoing historic mine activity impacts, several Illinois agencies have cleaned up abandoned mine sites, where feasible, by converting the land to public recreation and wildlife habitat. Most notably, Argyle Lake State Park, located north of Colchester just outside of the project area, consists of 1,500 acres of mine land reclaimed in 1949 (IDNR 2005). Illinois EPA has identified several nonpoint sources as contributing to the La Moine/Missouri Creek watershed impairments such as crop production, impacts from abandoned mine lands and surface mining (Table 12).

Table 12. Potential nonpoint sources in project area based on 2014, 2016 305(b) list

Watershed	Segment	Causes	Sources
La Moine River	IL_DG-01	Fecal Coliform	Source Unknown
La Moine River	IL_DG-04	Fecal Coliform	Source Unknown
Missouri Creek	IL_DGD-01	Manganese	Source Unknown
Little Missouri Creek	IL_DGDA-01	Manganese and Dissolved Oxygen	Impacts from Abandoned Mine Lands (Inactive), Surface Mining and Crop Production (Crop Land or Dry Land)

a. No TMDL developed for DGD-01 and DGDA-01, see Section 5.

3.3.1 Stormwater Runoff

During wet-weather events (snowmelt and rainfall), pollutants are incorporated into runoff and can be delivered to downstream waterbodies. The resultant pollutant loads are linked to the land uses and practices in the watershed. Agricultural and developed areas can have significant effects on water quality if proper best management practices are not in place. The main pollutants of concern associated with agricultural runoff are sediment, nutrients, pesticides, and bacteria. Storm water from developed areas can be contaminated with oil, grease, chlorides, pesticides, herbicides, nutrients, viruses, bacteria, metals, and sediment.

In addition to pollutants, alterations to a watershed's hydrology as a result of land use changes can detrimentally affect habitat and biological health. Imperviousness associated with developed land uses and agricultural field tiling can result in increased peak flows and runoff volumes and decreased base flow as a result of reduced ground water discharge. The increased peak flows and runoff volumes tend to increase streambank erosion. These more powerful flows have greater ability to move larger sediment particles farther, which may result in downstream sedimentation when the in-stream flow decreases and slows down. Drain tiles drain the subsoil and also transport agricultural runoff directly to ditches and streams, whereas runoff flowing over the land surface may infiltrate to the subsurface and may flow through vegetated riparian areas.

3.3.2 Erosion

Erosion of sediments can be a source of high manganese in the watershed. Manganese is naturally occurring within the glaciated soils in the watershed. Various forms of erosion are a common source of sediment. Typically, erosion will increase as stream velocity and peak flow increases. Runoff over impervious surfaces and through agricultural drain tiles will have higher velocities and peak flows, and thus, increase erosion.

Sheet erosion is the detachment of soil particles by raindrop impact, and their removal by water flowing overland as a sheet instead of in channels or rills. Rill erosion refers to the development of small, ephemeral concentrated flow paths, which function as both sediment source and sediment delivery systems for erosion on hillsides. Sheet and rill erosion occur more frequently in areas that lack or have sparse vegetation. Bank and channel erosion refers to the wearing away of the banks and channel of a stream or river. High rates of bank and channel erosion can often be associated with water flow and sediment dynamics being out of balance that can result from land use activities that either alter flow regimes, adversely affect the floodplain and streamside riparian areas, or a combination of both. Hydrology is a major driver for both sheet/rill and stream channel erosion.

Figure 11. Examples of erosion: Top picture is bank/channel erosion; Bottom picture is sheet and rill erosion.

3.3.3 Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems (e.g., septic systems) that are properly designed and maintained should not serve as a source of contamination to surface waters. However, onsite systems do fail for a variety of reasons including excessive water use, poor design, physical damage, and lack of maintenance. Common limitations that contribute to failure include: seasonal high water table, fine-grained soils, bedrock, and fragipan (i.e., altered subsurface soil layer that restrict water flow and root penetration). When these septic systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration) there can be adverse effects to surface waters (Horsely and Witten 1996). Septic systems contain wastewater from homes and businesses and can be significant sources of pathogens and nutrients.

Watershed specific data are not available for septic systems. However, county wide data available from the National Environmental Service Center for 1992 and 1998 are available and area weighted to estimate the number of septic systems in each watershed (Table 13).

Table 13. Estimated (area weighted) septic systems

Watershed	Number of septic systems	Septic systems per square mile
La Moine River (IL_DG-01)	8,073	9
La Moine River (IL_DG-04)	3,666	9
Missouri Creek (IL_DGD-01)	851	9
Little Missouri Creek (IL_DGDA-01)	316	9

Source: NESC 1992 and 1998 (data obtained from EPA Region 5 STEPL Model database).
a. No TMDL developed for DGD-01 and DGDA-01, see Section 5 and 6.

3.3.4 Animal Feeding Operations (AFOs)

Animal feeding operations that are not classified as CAFOs are known as animal feeding operations (AFOs) in Illinois. Non-CAFO AFOs are considered nonpoint sources by U.S. EPA. AFOs in Illinois do not have state permits. However, they are subject to state livestock waste regulations and may be inspected by the Illinois EPA, either in response to complaints or as part of the Agency's field inspection responsibilities to determine compliance by facilities subject to water pollution and livestock waste regulations.

The animals raised in AFOs produce manure that is stored in pits, lagoons, tanks and other storage devices. The manure is then applied to area fields as fertilizer. When stored and applied properly, this beneficial re-use of manure provides a natural source for crop nutrition. It also lessens the need for fuel and other natural resources that are used in the production of fertilizer. AFOs, however, can pose environmental concerns, including the following:

- Manure can leak or spill from storage pits, lagoons, tanks, etc.
- Improper application of manure can contaminate surface or ground water.
- Manure over application can adversely impact soil productivity.

Livestock are potential sources of bacteria, nutrients, and other oxygen demanding substances to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county wide data available from the 2012 Census of Agriculture were downloaded and area weighted to estimate animal populations in the watershed (Table 14). An estimated 119,749 animals are in the watershed.

Table 14. Estimated (area weighted) number of livestock animals

Watershed	Cattle	Poultry	Sheep	Hogs	Horses
La Moine River (IL_DG-01)	18,579	697	826	99,098	549
La Moine River (IL_DG-04)	9,560	378	526	48,843	307
Missouri Creek (IL_DGD-01)	1,823	70	82	7,343	59
Little Missouri Creek (IL_DGDA-01)	602	16	35	2,323	25

Source: 2012 Census of Agriculture (Illinois); a. No TMDLs developed for DGD-01 and DGDA-01, see Section 5 and 6.

3.3.5 Wildlife

Wildlife such as deer, raccoon, and waterfowl also contribute to fecal coliform loading in the watershed; however, these sources are not typically managed. While no specific information is available on wildlife populations in the La Moine watershed or their potential to impact fecal coliform loadings, according to the University of Illinois–Extension, the highest densities of white tail deer in the state are found in wooded areas in watersheds of major rivers such as the La Moine. White tail deer are also known to reside in areas with intensively farmed land and suburban municipalities (University of Illinois–Extension, 2017).

4. TMDL Endpoints

This section presents information on the water quality impairments within the La Moine/Missouri Creek watershed and the associated water quality standards (WQS) and targets.

4.1 Applicable Standards

WQS are designed to protect beneficial uses. The authority to designate beneficial uses and adopt WQS is granted through Title 35 of the Illinois Administrative Code. Designated uses to be protected in surface waters of the state are defined under Section 303, and WQS are designated under Section 302 (Water Quality Standards). Designated uses and water quality criteria are discussed below.

4.1.1 Designated Uses

Illinois EPA uses rules and regulations adopted by the Illinois Pollution Control Board (IPCB) to assess the designated use support for Illinois waterbodies. The following are the use support designations provided by the IPCB that apply to water bodies in the La Moine/Missouri Creek watershed:

General Use Standards – These standards protect for aquatic life, wildlife, agricultural uses, primary contact (where physical configuration of the waterbody permits it, any recreational or other water use in which there is prolonged and intimate contact with the water involving considerable risk of ingesting water in quantities sufficient to pose a significant health hazard, such as swimming and water skiing), secondary contact (any recreational or other water use in which contact with the water is either incidental or accidental and in which the probability of ingesting appreciable quantities of water is minimal, such as fishing, commercial and recreational boating, and any limited contact incident to shoreline activity), and most industrial uses. These standards are also designed to ensure the aesthetic quality of the state's aquatic environment.

4.1.2 Water Quality Criteria and TMDL Endpoints

Environmental regulations for the State of Illinois are contained within the Illinois Administrative Code, Title 35. Specifically, Title 35, Part 302 contains water quality standards promulgated by the Illinois Pollution Control Board. This section presents the standards applicable to impairments within the study area. Water quality standards and TMDL endpoints to be used for TMDL development in the La Moine/Missouri Creek watershed are provided in Table 15.

Table 15. Summary of water quality standards and TMDL endpoints for the La Moine/Missouri Creek watershed

Parameter	Units	General Use Water Quality Standard
Fecal Coliform [a]	#/100 mL	400 in <10% of samples [b]
		Geometric mean < 200 [c]
Manganese (dissolved)	µg/L	Acute standard: $e^{A+Bln(H)} \times 0.9812$, where A=4.9187 and B=0.7467; H=hardness Chronic standard: $e^{A+Bln(H)} \times 0.9812$, where A=4.0635 and B=0.7467; H=hardness
Dissolved Oxygen [d]	mg/L	*Instantaneous minimum:* 5.0 *(March – July)* 3.5 *(August – February)*
		Daily minimum averaged over 7 days: 4.0 *(August – February)*
		Daily mean averaged over 7 days: 6.0 *(March - July)* 5.5 *(August – February)*

a. Fecal coliform standards are applicable for the recreation season only (May through October).
b. Standard shall not be exceeded by more than 10% of the samples collected during a 30 day period.
c. Geometric mean based on minimum of 5 samples taken over not more than a 30 day period.
d. Applies to the dissolved oxygen concentration in the main body of all streams, in the water above the thermocline of thermally stratified lakes and reservoirs, and in the entire water column of unstratified lakes and reservoirs. Enhanced dissolved oxygen criteria are found in 35 Ill Adm. Code 302.206, including the list of waters with enhanced dissolved oxygen protection and methods for assessing attainment of dissolved oxygen minimum and mean values

According to Illinois water quality standards, primary contact means ...*any recreational or other water use in which there is prolonged and intimate contact with the water involving considerable risk of ingesting water in quantities sufficient to pose a significant health hazard, such as swimming and water skiing* (35 Ill. Adm. Code 301.355). The assessment of primary *contact* use is based on fecal coliform bacteria data. The General Use Water Quality Standard for fecal coliform bacteria specifies that during the months of May through October, based on a minimum of five samples taken over not more than a 30-day period, fecal coliform bacteria counts shall not exceed a geometric mean of 200/100 mL, nor shall more than 10 percent of the samples during any 30-day period exceed 400/100 mL (35 Ill. Adm. Code 302.209). This standard protects primary contact use of Illinois waters by humans.

Due to limited state resources, fecal coliform bacteria are not normally sampled at a frequency necessary to apply the General Use standard, i.e., at least five times per month during May through October, and very little data available from others are collected at the required frequency. Therefore, assessment guidelines are based on application of the standard when sufficient data is available to determine standard exceedances; but, in most cases, attainment of primary contact use is based on a broader methodology intended to assess the likelihood that the General Use standard is being attained.

To assess primary contact use, Illinois EPA uses all fecal coliform bacteria from water samples collected in May through October, over the most recent five-year period (i.e., 2011 through 2015 for this report). Based on these water samples, geometric means and individual measurements of fecal coliform bacteria are compared to the concentration thresholds in Table 16 and Table 17. To apply the guidelines, the geometric mean of fecal coliform bacteria concentration is calculated from a minimum of five samples collected during a 30-day period between May and October, when available. No more than 10 percent of all the samples may exceed 400/100 mL for a waterbody to be considered Fully Supporting.

Table 16. Guidelines for assessing primary contact use in Illinois streams and inland lakes

Degree of Use Support	Guidelines
Fully Supporting (Good)	No exceedances of the fecal coliform bacteria standard in the last five years and the geometric mean of all fecal coliform bacteria observations ≤200/100 ml, and ≤10% of all observations exceed 400/100 ml.
Not Supporting (Fair)	One exceedance of the fecal coliform bacteria standard in the last five years (when sufficient data is available to assess the standard) or The geometric mean of all fecal coliform bacteria observations in the last five years ≤200/100 ml, and >10% of all observations in the last five years exceed 400/100 ml or The geometric mean of all fecal coliform bacteria observations in the last five years >200/100 ml, and ≤25% of all observations in the last five years exceed 400/100 ml.
Not Supporting (Poor)	More than one exceedance of the fecal coliform bacteria standard in the last five years (when sufficient data is available to assess the standard) or The geometric mean of all fecal coliform bacteria observations in the last five years >200/100 ml, and >25% of all observations in the last five years exceed 400/100 ml

Table 17. Guidelines for identifying potential causes of impairment of primary contact use in Illinois Streams and freshwater lakes

Potential Cause	Basis for Identifying Cause - Numeric Standard[1]
Fecal Coliform	Geometric mean of at least five fecal coliform bacteria observations collected over not more than 30 days during May through October >200/100 ml or > 10% of all such fecal coliform bacteria observations exceed 400/100 ml or Geometric mean of all fecal coliform bacteria observations (minimum of five samples) collected during May through October >200/100 ml or > 10% of all fecal coliform bacteria observation exceed 400/100 ml.

1. The applicable fecal coliform standard (35 Ill. Adm. Code, 302, Subpart B, Section 302.209) requires a minimum of five samples in not more than a 30-day period. However, because this number of samples is seldom available in this time frame, the criteria are also based on a minimum of five samples over the most recent five-year period.

Aquatic life use assessments in streams are typically based on the interpretation of biological information, physicochemical water data and physical-habitat information from the Intensive Basin Survey, Ambient Water Quality Monitoring Network or Facility-Related Stream Survey programs. The primary biological measures used are the fish Index of Biotic Integrity (Karr et al. 1986; Smogor 2000, 2005), the macroinvertebrate Index of Biotic Integrity (Tetra Tech 2004) and the Macroinvertebrate Biotic Index (Illinois EPA 1994). Physical habitat information used in assessments includes quantitative or qualitative measures of stream bottom composition and qualitative descriptors of channel and riparian conditions. Physicochemical water data used include measures of —conventional parameters (e.g., dissolved oxygen, pH and temperature), priority pollutants, non-priority pollutants, and other pollutants (U.S. EPA 2002a). In a minority of streams for which biological information is unavailable, aquatic life use assessments are based primarily on physicochemical water data.

When a stream segment is determined to be Not Supporting aquatic life use, generally, one exceedance of an applicable Illinois water quality standard (related to the protection of aquatic life) results in identifying the parameter as a potential cause of impairment. Additional guidelines used to determine potential causes of impairment include site-specific standards (35 Ill. Adm. Code 303, Subpart C), or adjusted standards published in the Illinois Pollution Control Board's Environmental.

5. Data Analysis

An important step in the TMDL development process is the review of water quality conditions, particularly data and information used to list segments. Examination of water quality monitoring data is a key part of defining the problem that the TMDL is intended to address This section provides a review of available water quality information provided by Illinois EPA and USGS. The period of record used to assess impairment is 2011-2015 for fecal coliform and 2006-2015 for all other pollutants. Note that additional data were collected in 2016 for select impairments, see Section 6 for a summary of this information. Each data point was reviewed to ensure the use of quality data in the analysis below.

For each impaired segment, the available data are summarized and presented with the minimum, maximum, and average concentrations. The coefficient of variation (CV) is also included to provide a measure of the extent of variability as relates to the mean. The number of exceedances of the standard are also provided.

5.1 La Moine River

The La Moine River is listed as impaired along two segments: DG-01 and DG-04. DG-04 is listed as impaired due to fecal coliform. DG-01 is downstream of DG-04 and is also impaired for primary contact recreation due to fecal coliform. There is one Illinois EPA sampling site on each of the impaired reaches. There are insufficient data to determine if other stream segments within the watershed are contributing to impairments.

5.1.1 DG-04

Illinois EPA collected a total of 9 fecal coliform samples at DG-04 from 2011-2013 (Table 18 and Figure 12). There are 2 reported exceedances of the 400 cfu/100 mL single sample maximum standard, with an average reported value above the standard at 1,089 cfu/100 mL. Historical data at the site from 1990-2006 and 2009-2010 have a similar trend with 37 reported exceedances and an average well above the standard.

Table 18. Data summary, La Moine River DG-04

Sample Site	No. of samples	Minimum (cfu/100 mL)	Average (cfu/100 mL)	Maximum (cfu/100 mL)	CV (standard deviation/ average)	Number of exceedances of the single sample maximum standard (400 cfu/100 mL)
Fecal Coliform						
DG-04 (USGS 05584500)	9	24	1,089	7,900	2.23	2
DG-04 (USGS 05584500)[a]	114	5	2,379	52,000	3.09	37

a. Data from 1990-2006 and 2009-2010; greater than 5 years old, not used to assess impairment.

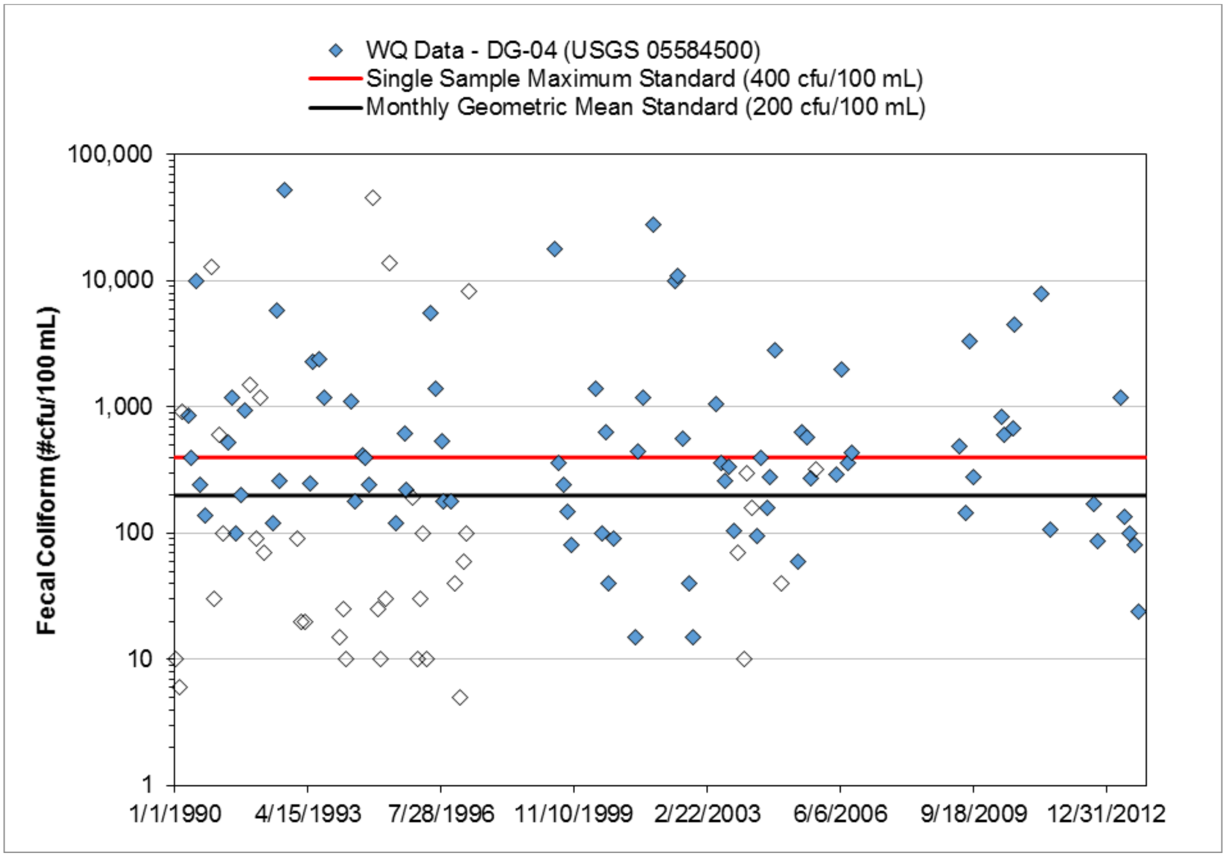

Figure 12. Fecal coliform water quality time series, La Moine River DG-04. Unfilled points indicate samples outside the standard window.

Possible causes for high bacteria concentrations include NPDES-permitted facilities, livestock, and onsite wastewater treatment systems. A total of nine NPDES-permitted facilities discharge to the impaired segment or within the watershed. NPDES permits also include description of SSOs from Colchester and Macomb. Between 2012 and 2016, discharge monitoring records indicate unpermitted SSOs during 2015 and 2016 in Colchester; there were no monitored SSOs from Macomb during this time period. In addition, livestock (including one CAFO) and onsite wastewater treatment systems in the watershed amount to approximately 150 animal units per square mile and nine systems per square mile, respectively. Wildlife can also be a source of fecal coliform with almost 20 percent of the watershed in forest, providing habitat for deer and other wildlife.

5.1.2 DG-01

DG-01 is located at the mouth of the watershed, and therefore sources of pollutants present within the entire La Moine/Missouri Creek watershed potentially affect this impaired stream segment. Illinois EPA collected 14 fecal coliform samples at DG-01 from 2011-2013 (Table 19 and Figure 13). There are 2 reported exceedances of the 400 cfu/100 mL single sample maximum standard, with an average reported value above the standard at 922 cfu/100 mL. Illinois EPA historic data at the site prior to 2011 have a similar trend with 35 reported exceedances and an average well above the single sample maximum standard.

Table 19. Data summary, La Moine River DG-01

Sample Site	No. of samples	Minimum (cfu/100 mL)	Average (cfu/100 mL)	Maximum (cfu/100 mL)	CV (standard deviation/ average)	Number of exceedances of the single sample maximum standard (400 cfu/100 mL)
Fecal Coliform						
DG-01 (USGS 05585000)	14	41	922	9,500	2.63	2
DG-01 (USGS 05585000)[a]	113	5	2,005	40,000	2.91	35

a. Data from 1990-2010; greater than 5 years old., not used to assess impairment.

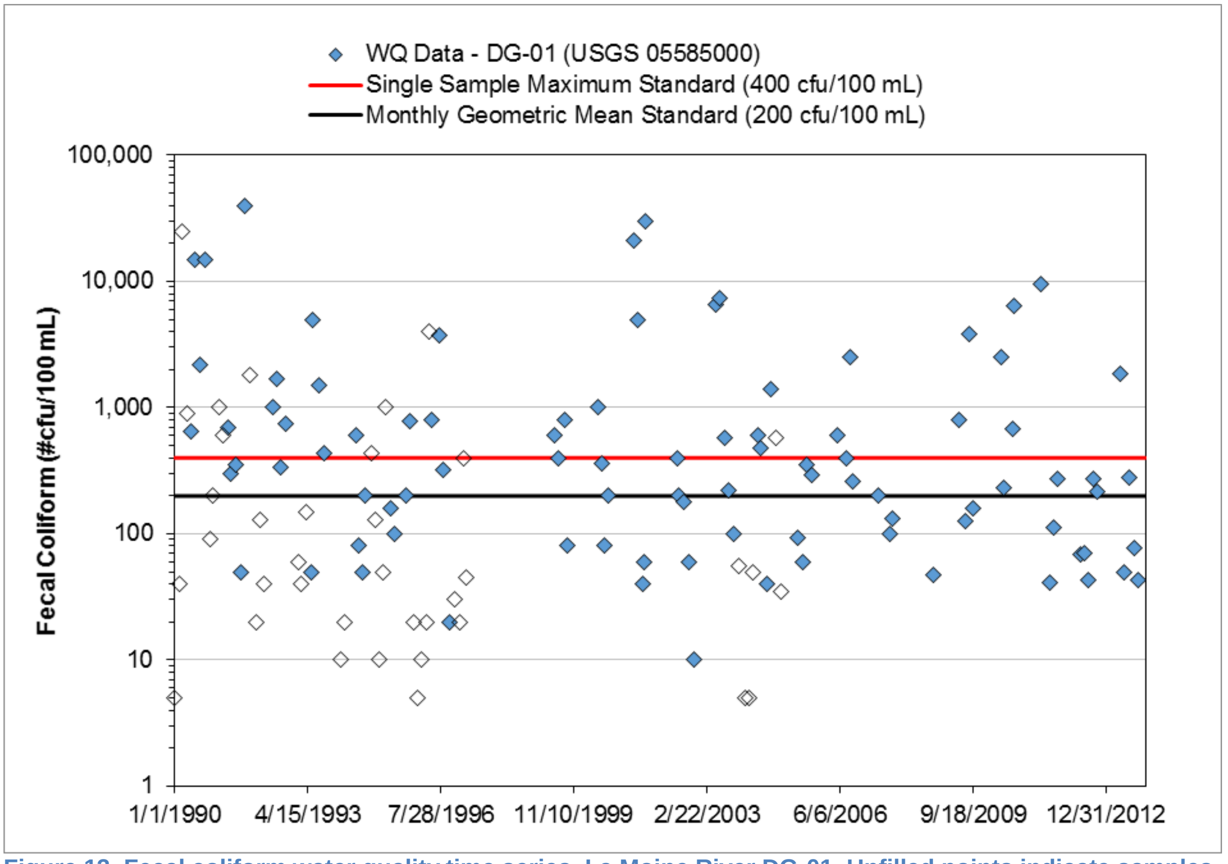

Figure 13. Fecal coliform water quality time series, La Moine River DG-01. Unfilled points indicate samples outside the standard window.

Exceedances of the single sample maximum standard occur during high and low flow conditions indicating many sources are contributing to impairment. Possible causes for high bacteria concentrations include upstream NPDES-permitted facilities, livestock, and onsite wastewater treatment systems. Two NPDES-permitted facilities discharge to tributaries of the impaired stream. Nine other facilities discharge in the upper part of the watershed, and are not likely contributing to the high fecal coliform concentrations in DG-01. The NPDES permit for Mount Sterling includes description of potential SSOs, however between 2012 and 2016 there were no reported SSOs. In addition to NPDES-permitted facilities, livestock, and several thousand onsite wastewater treatment systems are present within the watershed. In total, there are approximately 140 animal units and 9 onsite wastewater treatment systems per square mile potentially contributing fecal coliform to the watershed. Wildlife can also be a source of fecal coliform in the watershed; approximately 27 percent of the watershed is forested, providing suitable habitat for deer and other wildlife.

5.2 Missouri Creek (DGD-01)

Missouri Creek is listed as being impaired for aquatic life due to elevated levels of manganese. One Illinois EPA sampling site was identified on Missouri Creek, DGD-02. As part of the Illinois EPA's Intensive Basin Survey, four samples have been collected at the site, two in 2007 and two in 2012 (Table 20 and Figure 14). There were no exceedances of the standard. Three historic samples collected in 2002 at the site also do not exceed the standard, with a maximum concentration of 410 µg/L. Data do not indicate manganese impairment.

Table 20. Data summary, Missouri Creek DGD-01

Sample Site	No. of samples	Minimum (µg/L)	Average (µg/L)	Maximum (µg/L)	CV (standard deviation/ average)	Number of exceedances of general use water quality standard
Dissolved Manganese						
DGD-02	4	58	753	1,300	0.60	0
DGD-02[a]	3	84	215	410	0.66	0

a. Data from 2002; greater than 10 years old, not used to assess impairment.

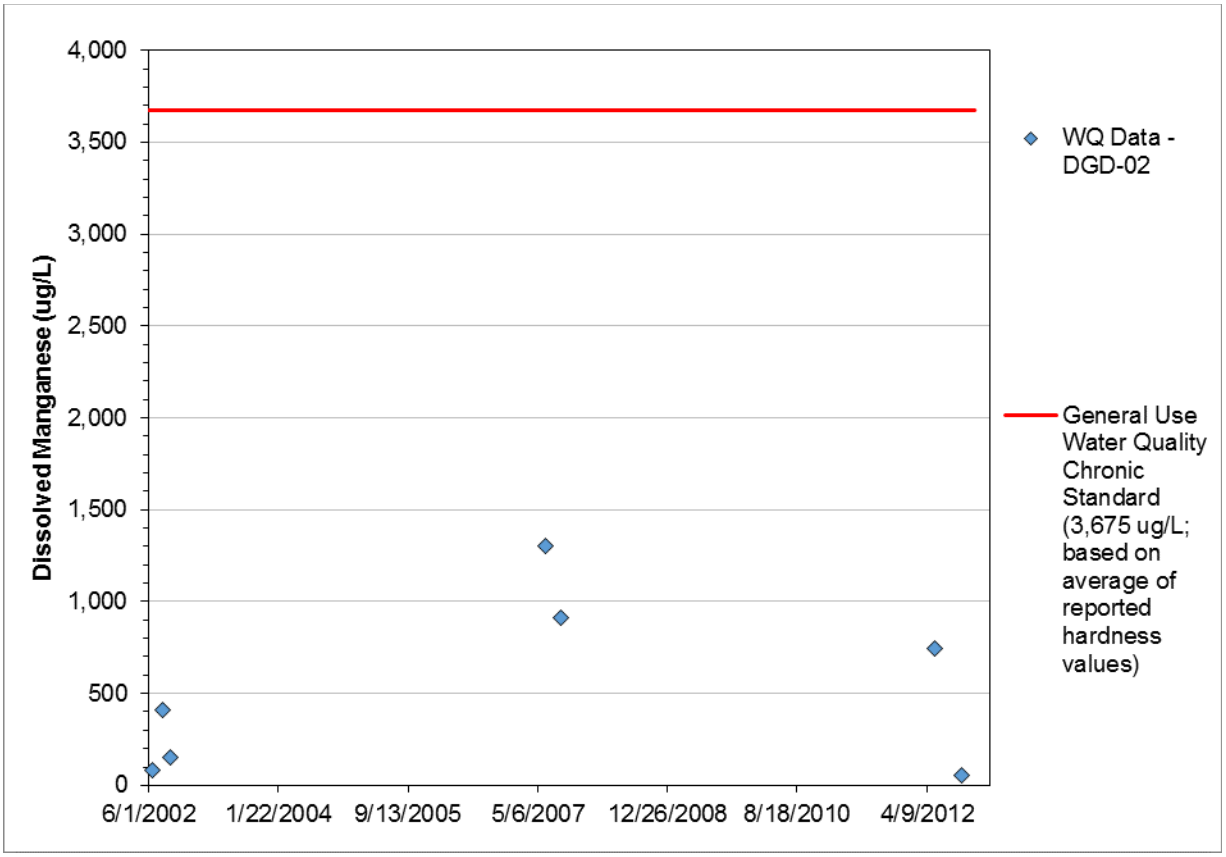

Figure 14. Dissolved manganese water quality time series, Missouri Creek DGD-01.

Manganese is naturally occurring in the watershed's glacial soils which is transported to waterbodies during runoff events and through groundwater. Land use disturbances such as agricultural activities, mining, and development can increase sediment loss and associated manganese. Erosion in near channel areas that is resulting from channel downcutting and potentially altered hydrology can also contribute sediment and associated manganese to the creek. Groundwater may be high in manganese due to percolation through glacial soils. There may be other unknown sources of manganese in the watershed.

5.3 Little Missouri Creek (DGDA-01)

Little Missouri Creek is impaired for aquatic life due to elevated levels of manganese and low levels of dissolved oxygen. One Illinois EPA sampling site was identified on Little Missouri Creek, DGDA-01 (Table 21, Figure 15, and Figure 16). Two samples were collected in 2012 during May and September. There were no dissolved manganese exceedances reported. Two historical samples collected during 2002 also did not exceed the standard with a maximum value of 1,300 µg/L. Recent data do not indicate manganese impairment.

Two dissolved oxygen samples collected in 2012 (May and September) met the instantaneous minimum standards of 5 mg/L (March through July) and 3.5 mg/L (August through February). Historical data collected in 2002 include one sample collected in August 2002 is below the relevant instantaneous minimum standard. Recent data do not indicate dissolved oxygen impairment, however additional monitoring is recommended to verify impairment status and support potential de-listing.

Table 21. Data summary, Little Missouri Creek DGDA-01

Sample Site	No. of samples	Minimum (µg/L)	Average (µg/L)	Maximum (µg/L)	CV (standard deviation/ average)	Number of exceedances of general use water quality standard
Dissolved Manganese						
DGDA-01	2	31	153	275	0.80	0
DGDA-01[a]	3	130	843	1,300	0.61	0
Sample Site	**No. of samples**	**Minimum (mg/L)**	**Average (mg/L)**	**Maximum (mg/L)**	**CV (standard deviation/ average)**	**Number of exceedances of general use water quality standard (>5 mg/L (Mar-Jul) and >3.5 mg/L (Aug-Feb))**
Dissolved Oxygen						
DGDA-01	2	6.7	7.8	8.9	0.14	0
DGDA-01[a]	3	2.6	4.4	7.2	0.45	1

a. Data from 2002; greater than 10 years old, not used to assess impairment.

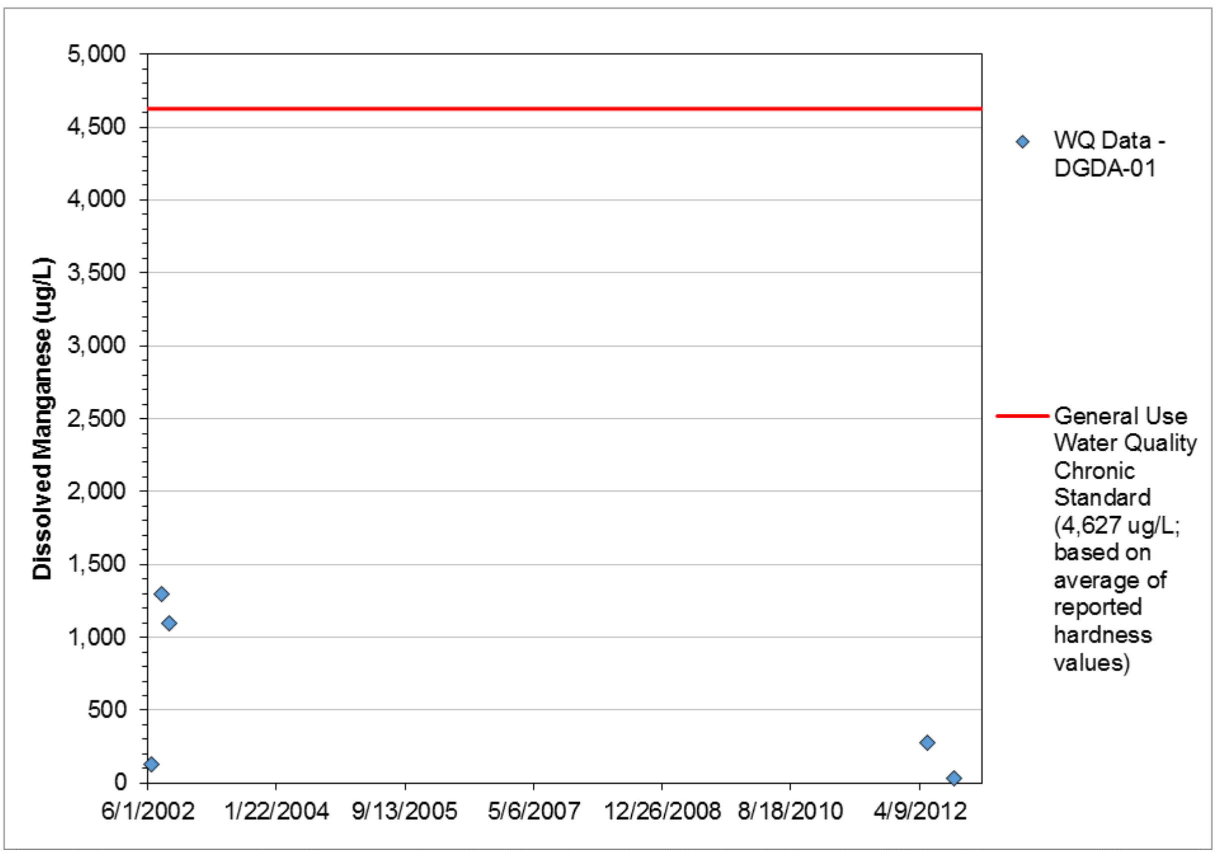

Figure 15. Dissolved manganese water quality time series, Little Missouri Creek DGDA-01.

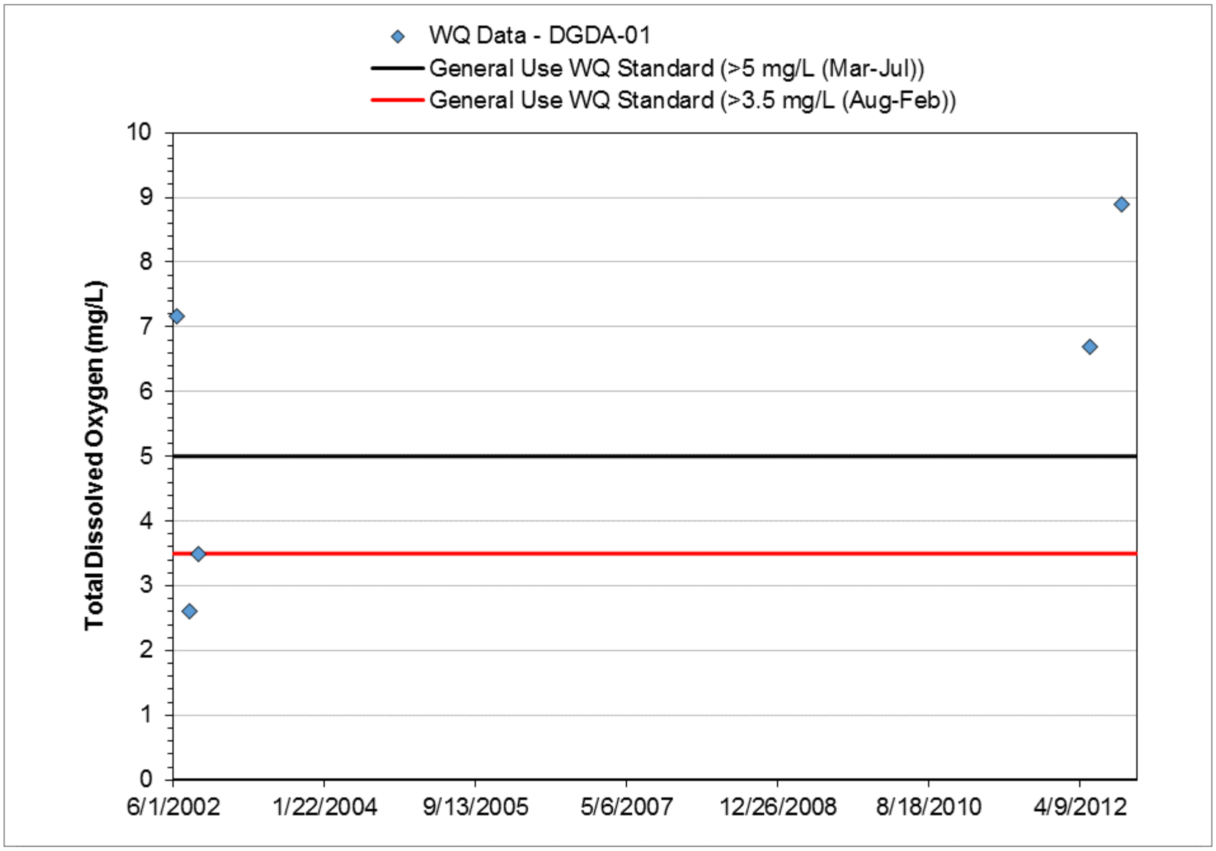

Figure 16. Dissolved oxygen water quality time series, Little Missouri Creek DGDA-01.

Manganese is naturally occurring in the watershed's glacial soils which is transported to waterbodies during runoff events and through groundwater. Land use disturbances such as agricultural activities and development can increase sediment loss and associated manganese. Erosion in near channel areas that is resulting from channel downcutting can also contribute sediment and associated manganese to the creek. In addition, within the Little Missouri Creek watershed, historical and current mining activities are potential sources. Mining activities can result in erosion, transporting sediment and associated manganese to water bodies.

Potential causes of low dissolved oxygen include altered land use in the watershed and sources of biochemical oxygen demand. In addition, in-stream conditions may also be affecting dissolved oxygen levels in the river. Ditching and lack of riffles and other natural structures can contribute to low dissolved oxygen levels. Agricultural land uses and livestock can also contribute to low dissolved oxygen in receiving waters. In addition, runoff from historic and active mining areas can also affect dissolved oxygen concentrations in the creek.

6. Stage 2 Data Collection

Data satisfy two key objectives for Illinois EPA, enabling the agency to make informed decisions about the resource. These objectives include developing information necessary to:

- Determine if the impaired areas are meeting applicable water quality standards for their respective designated use(s); and
- Support modeling and assessment activities required to allocate pollutant loadings for all impaired areas where water quality standards are not being met.

Additional data points can be needed to verify impairment, understand probable sources, calculate reductions, develop validated water quality models, and develop effective implementation plans. Illinois EPA collected data in August 2016 that included field data and laboratory assessment of fecal coliform within two mainstem La Moine River segments DG-01 and DG-04 (Figure 17 and Table 22). The fecal coliform single sample maximum was exceeded in each segment and the geometric mean (based on 5 samples, DG-01 geometric mean was 474 cfu/100 mL and the DG-04 geometric mean was 782 cfu/100 mL) also exceeded the standard in each segment. These data confirm impairment.

Two additional dissolved oxygen samples were collected along Little Missouri Creek (DGDA-01) in August 2016. The dissolved oxygen concentration was 5.0 mg/L on August 4th 2016 and 3.5 mg/L on August 11th 2016. These data, along with existing monitoring data presented in Section 5, do not indicate an impairment due to low dissolved oxygen in Little Missouri Creek and a TMDL is not being developed.

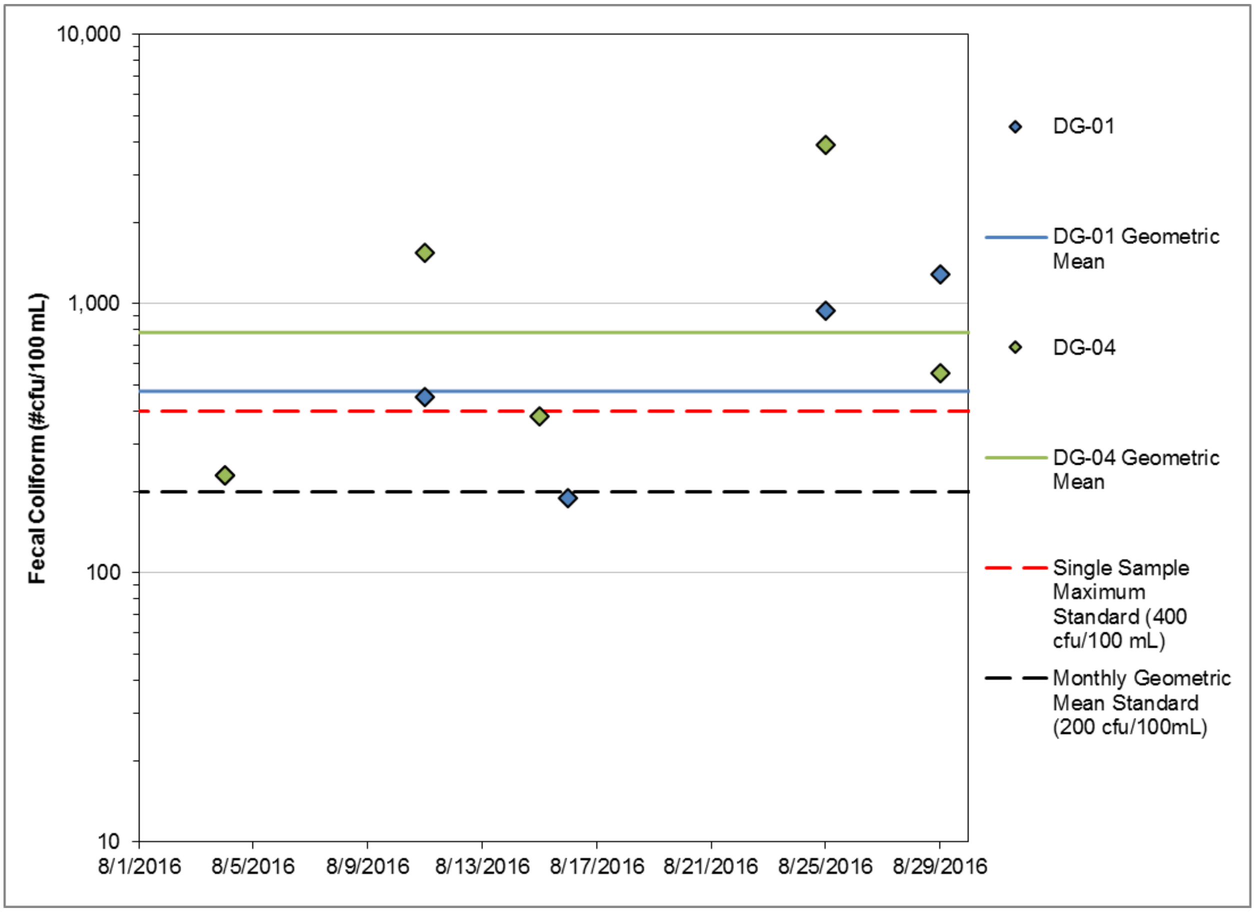

Figure 17. Fecal coliform water quality time series of sampling completed by Illinois EPA in August 2016.

Table 22. Summary of fecal coliform sampling completed by Illinois EPA in August 2016

Name	Sample Site	No. of Samples	Minimum (cfu/100 mL)	Maximum (cfu/100 mL)	Geometric Mean (cfu/100 mL)	Percent reduction needed to meet geometric mean standard (200 cfu/100 mL)
La Moine River	DG-01	5	189	1,290	474	58%
La Moine River	DG-04	5	231	3,900	782	74%

7. TMDL Derivation

The first stage of this project included an assessment of available data, followed by evaluation of their credibility. The types of data available, their quantity and quality, and their spatial and temporal coverage relative to impaired segments or watersheds drive the approaches used for TMDL model selection and analysis. Credible data are those that meet specified levels of data quality, with acceptance criteria defined by measurement quality objectives, specifically their precision, accuracy, bias, representativeness, completeness, and reliability. The following sections describe the methods used to derive TMDLs.

TMDLs are developed for waterbodies that have been verified as impaired. TMDLs will not be developed for the following impairments:

- Manganese in Missouri Creek (DGD-01) and Little Missouri Creek (DGDA-01) was found to be in compliance with water quality standards and are not impaired
- Dissolved oxygen in Little Missouri Creek (DGDA-01) was found to be in compliance with water quality standards and is not impaired

Table 23. TMDLs included in Stage 3

Name	Segment ID	Designated Uses	TMDL Parameter
La Moine River	DG-01	Primary contact recreation	Fecal coliform
	DG-04	Primary contact recreation	Fecal coliform

A waterbody's loading capacity represents the maximum rate of pollutant loading that can be assimilated without violating water quality standards (40 CFR 130.2(f)). Establishing the relationship between in-stream water quality and source loading is an important component of TMDL development. It allows the determination of the relative contribution of sources to total pollutant loading and the evaluation of potential changes to water quality resulting from implementation of various management options. The following section describes the methodology used in this analysis; results are then presented by waterbody in Section 9.

A TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards. TMDLs are composed of the sum of individual wasteload allocations (WLAs) for regulated sources and load allocations (LAs) for unregulated sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody and may contain a reserve capacity (RC) if needed. Conceptually, this is defined by the equation:

$$\textbf{TMDL} = \sum \textbf{WLAs} + \sum \textbf{LAs} + \textbf{MOS} + \textbf{RC}$$

Section 8 presents the allowable loads and associated allocations for each of the impaired waterbodies in the watershed.

7.1 Loading Capacity and Reductions

A duration curve approach is used to evaluate the relationships between hydrology and water quality and calculate the TMDLs for all stream impairments. The primary benefit of duration curves in TMDL development is to provide insight regarding patterns associated with hydrology and water quality concerns. The duration curve approach is particularly applicable because water quality is often a function of stream flow. For instance, sediment concentrations typically increase with rising flows as a result of factors such as channel scour from higher velocities. Other parameters, such as chloride, may be more concentrated at low flows and more diluted by increased water volumes at higher flows. The use of duration curves in water quality assessment creates a framework that enables data to be characterized by flow conditions. The method provides a visual display of the relationship between stream flow and water quality.

Stream flow for all impairments was estimated from USGS gauges within or adjacent to the impairment watersheds. Stream flow data for all relevant USGS gauges were downloaded from the National Water Information System (NWIS; https://waterdata.usgs.gov/nwis) and area-weighted to relevant impairment watersheds depending on the gauges' watershed area relative to the impairment watershed area. The stream flow estimation source for all impairments is presented Table 24. Both of the La Moine mainstem impairments have USGS gages in close proximity.

Table 24. USGS gauges to estimate stream flow for impairments

Gage ID	Location	Impaired Segment(s)
05584500	La Moine River at Colmar, IL	La Moine River (DG-04)
05585000	La Moine River at Ripley, IL	La Moine River (DG-01)

Allowable pollutant loads have been determined through the use of load duration curves. Discussions of load duration curves are presented in *An Approach for Using Load Duration Curves in the Development of TMDLs* (U.S. EPA 2007). This approach involves calculating the allowable loadings over the range of flow conditions expected to occur in the impaired stream by taking the following steps:

1. A flow duration curve for the stream is developed by generating a flow frequency table and plotting the data points to form a curve. The data reflect a range of natural occurrences from extremely high flows to extremely low flows.

2. The flow curve is translated into a load duration (or TMDL) curve by multiplying each flow value (in cubic feet per second) by the water quality standard/target for a contaminant (mg/L or count/100 mL), then multiplying by conversion factors to yield results in the proper unit (i.e., pounds per day or count/day). The resulting points are plotted to create a load duration curve.

3. Each water quality sample is converted to a load by multiplying the water quality sample concentration by the average daily flow on the day the sample was collected. Then, the individual loads are plotted as points on the TMDL graph and can be compared to the water quality standard/target, or load duration curve.

4. Points plotting above the curve represent deviations from the water quality standard/target and the daily allowable load. Those plotting below the curve represent compliance with standards and the daily allowable load. Further, it can be determined which locations contribute loads above or below the water quality standard/target.

5. The area beneath the TMDL curve is interpreted as the loading capacity of the stream. The difference between this area and the area representing the current loading conditions is the load that must be reduced to meet water quality standards/targets.

6. The final step is to determine where reductions need to occur. Those exceedances at the right side of the graph occur during low flow conditions, and may be derived from sources such as illicit sewer

connections. Exceedances on the left side of the graph occur during higher flow events, and may be derived from sources such as runoff. Using the load duration curve approach allows Illinois EPA to determine which implementation practices are most effective for reducing loads on the basis of flow regime. If loads are considerable during wet-weather events (including snowmelt), implementation efforts can target those best management practices that will most effectively reduce stormwater runoff.

The stream flows displayed on load duration curves may be grouped into various flow regimes to aid with interpretation of the load duration curves (example shown in Figure 18). The flow regimes are typically divided into 10 groups, which can be further categorized into the following five hydrologic zones (U.S. EPA 2007):

- High flow zone: stream flows that plot in the 0 to 10-percentile range, related to flood flows.
- Moist zone: flows in the 10 to 40-percentile range, related to wet weather conditions.
- Mid-range zone: flows in the 40 to 60-percentile range, median stream flow conditions;
- Dry zone: flows in the 60 to 90-percentile range, related to dry weather flows.
- Low flow zone: flows in the 90 to 100-percentile range, related to drought conditions.

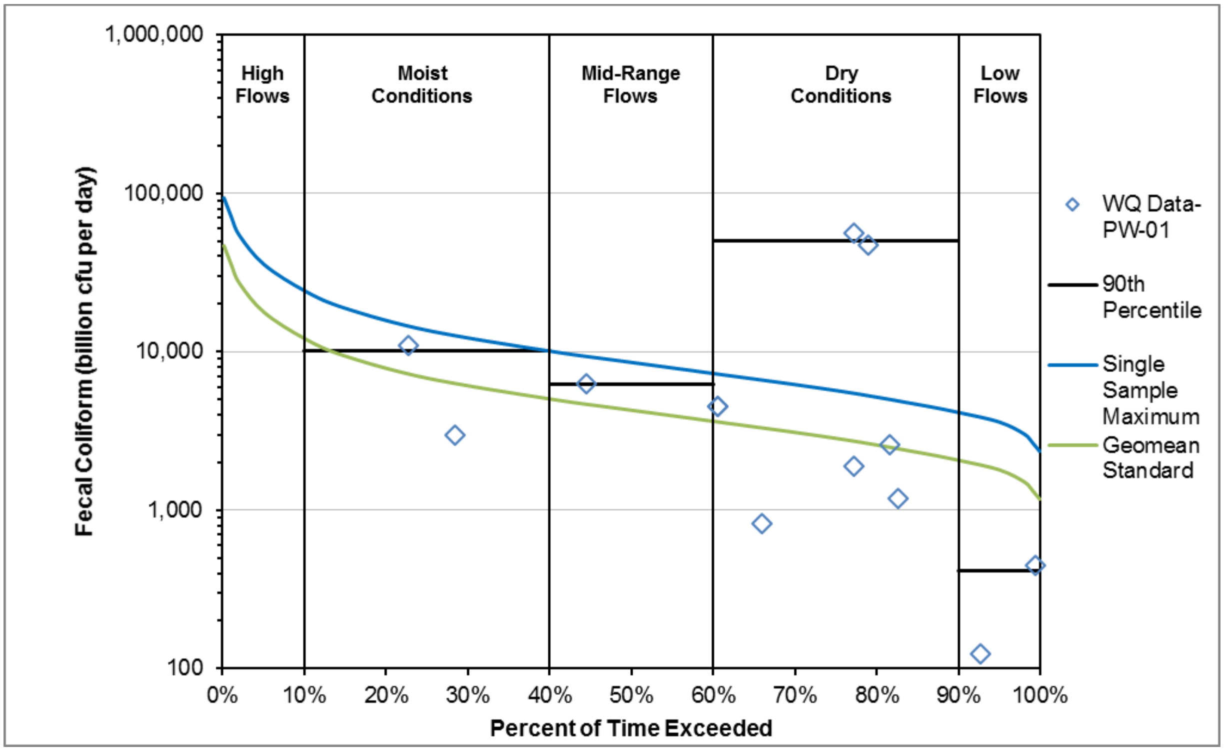

Figure 18. Example load duration curve for fecal coliform.

Fecal coliform TMDLs are based on compliance with both the single sample maximum standard (400 cfu/100 mL) and the geomean standard (200 cfu/100 mL). For the single sample maximum standard, reductions are based on the 90th percentile of the observed load and the median allowable load in each flow regime based on 2011-2016. 2016 is added to the dataset presented in Section 5 as a result of Stage 2 monitoring (see Section 6). Reductions relative to the geomean standard are concentration-based and were calculated using the geomean concentration of samples collected by Illinois EPA in August 2016.

The duration curve approach helps to identify the issues surrounding the impairment and to roughly differentiate between sources. Table 25 summarizes the general relationship between the five hydrologic zones and potentially contributing source areas (the table is not specific to any individual pollutant). For example, the table indicates that impacts from point sources are usually most pronounced during dry and low flow zones because there is less water in the stream to dilute their loads. In contrast, impacts from channel bank erosion is most pronounced during high flow zones because these are the periods during which stream velocities are high enough to cause erosion to occur.

Table 25. Relationship between duration curve zones and contributing sources

Contributing source area	Duration Curve Zone				
	High	Moist	Mid-range	Dry	Low
Point source				M	H
Livestock direct access to streams				M	H
Onsite wastewater systems	M	M-H	H	H	H
Riparian areas		H	H	M	
Stormwater: Impervious		H	H	H	
Stormwater: Upland	H	H	M		
Field drainage: Natural condition	H	M			
Field drainage: Tile system	H	H	M-H	L-M	
Bank erosion	H	M			

Note: Potential relative importance of source area to contribute loads under given hydrologic condition (H: High; M: Medium; L: Low).

7.2 Load Allocations

Load allocations represent the portion of the allowable daily load that is reserved for nonpoint sources and natural background conditions. The load allocations are based on subtracting the WLAs and the MOS from allowable loads. The load allocations are summarized in Section 8 for each of the waterbody pollutant combinations along with the baseline loads and WLAs.

7.3 Wasteload Allocations

National Pollutant Discharge Elimination System (NPDES) permitted sewage treatment plants (STP) and industrial facilities within the watershed with the potential to discharge pollutants to impairments are presented in Table 26. As required by the Clean Water Act (CWA), individual WLAs were developed for these permittees as part of the TMDL development process. Each facility's maximum design flow is used to calculate the WLA for the high flow zone and the average design flow was used for all other flow zones. Illinois assumes that facilities will have to discharge at their maximum flow during both high and moist flows based on the following:

> *For municipal NPDES permits in Illinois, page 2 of the NPDES permit lists 2 design flows: a design average flow (DAF) and a design maximum flow (DMF). These are defined in 35 Ill. Adm. Code 370.211(a) and (b) (see http://www.ipcb.state.il.us/documents/dsweb/Get/Document-12042/). Since rain (and to a certain extent, high ground water) causes influent flows to wastewater treatment facilities to increase and precipitation also leads to higher river levels, a correlation between precipitation and treatment flows exists. The load limits in these permits gives a tiered load limit, one based on DAF for flows of DAF and below, and another load limit in the permit for flows above DAF through DMF.*

Fecal coliform WLAs are based on compliance with the geometric mean fecal coliform water quality standard of 200 cfu/100 mL; the instantaneous water quality standard requiring that no more than 10% of the samples shall exceed 400 cfu/100 mL is also required to be met at the closest point downstream where recreational use occurs in the receiving water or where the water flows into a fecal coliform impaired segment. WLAs are provided for both the instantaneous and geomean water quality standards for those facilities discharging fecal coliform.

Table 26. Individual NPDES-permitted facilities discharging fecal coliform to impairments

IL Permit ID	Facility Name	Type of Discharge	Design Average Flow (MGD)	Design Maximum Flow (MGD)	Downstream Impairment(s)	Disinfection Exemption
IL0022411	Mt. Sterling, City of	STP	0.366	0.54	DG-01	Yes
IL0027570	Augusta STP	STP	0.093	0.2325	DG-04, DG-01	Yes
IL0028177	Colchester, City of	STP	0.17	0.47	DG-04, DG-01	Yes
IL0029688	Macomb, City of	STP	3	7.5	DG-04, DG-01	Yes
IL0042153	Plymouth, Village of	STP	0.06	0.3	DG-04, DG-01	Yes
IL0054267	Country Aire Estates MHP	STP	0.0126	0.0315	DG-04, DG-01	Yes
ILG580048	Industry, Village of	STP	0.075	0.1875	DG-04, DG-01	Yes

There are seven facilities with disinfection exemptions discharging to impairments. WLAs for facilities with disinfection exemptions were based on the design flows for each facility multiplied the water quality target. The resulting WLAs apply at the end of their respective disinfection exemption reach (Figure 19). The Village of Plymouth does not have a defined disinfection reach, the WLA applies to the effluent discharge in that case. The Effluent Disinfection Exemptions standards established by the Illinois Pollution Control Board (Title 35: Subtitle C, Part 378.101(c)) allow that waters unsuitable for primary contact activities (swimming), unlikely to allow incidental contact due to remoteness from any parks or residential areas, and unutilized for public and food processing water supply are exempt from fecal coliform water quality standards. Facilities with disinfection exemptions may be required to provide IEPA with updated information to demonstrate compliance with these requirements and facilities directly discharging into a fecal coliform impaired segment may have their disinfection exemption reviewed through future NPDES permitting actions. Three facilities (Mount Sterling, Colchester, and Macomb) also have special conditions included within NPDES permits that prohibit the discharge of overflow from SSOs. SSOs are not permitted, and therefore do not receive a WLA.

In addition to NPDES-permitted sewage treatment plants and industrial facilities, the area that produces manure, litter, or processed wastewater as the result of CAFOs is considered a point source that is regulated through the NPDES Program. In Illinois, the CAFO program is administered by the Illinois EPA through general permit number ILA01 (refer to the following Web site for more details: http://www.epa.state.il.us/water/cafo). The federal regulations for all CAFOs can be found in 40 CFR Parts 9, 122, and 412. U.S. EPA requires that CAFOs receive a WLA as part of the TMDL development process. There is one CAFO in the La Moine/Missouri Creek watershed: Pinnacle Genetics (ILA010002). The facility is located within the Troublesome Creek watershed. Troublesome Creek drains to impaired segment DG-04 of the La Moine River. CAFOs are not allowed to discharge pollutants, therefore the WLA is set at zero.

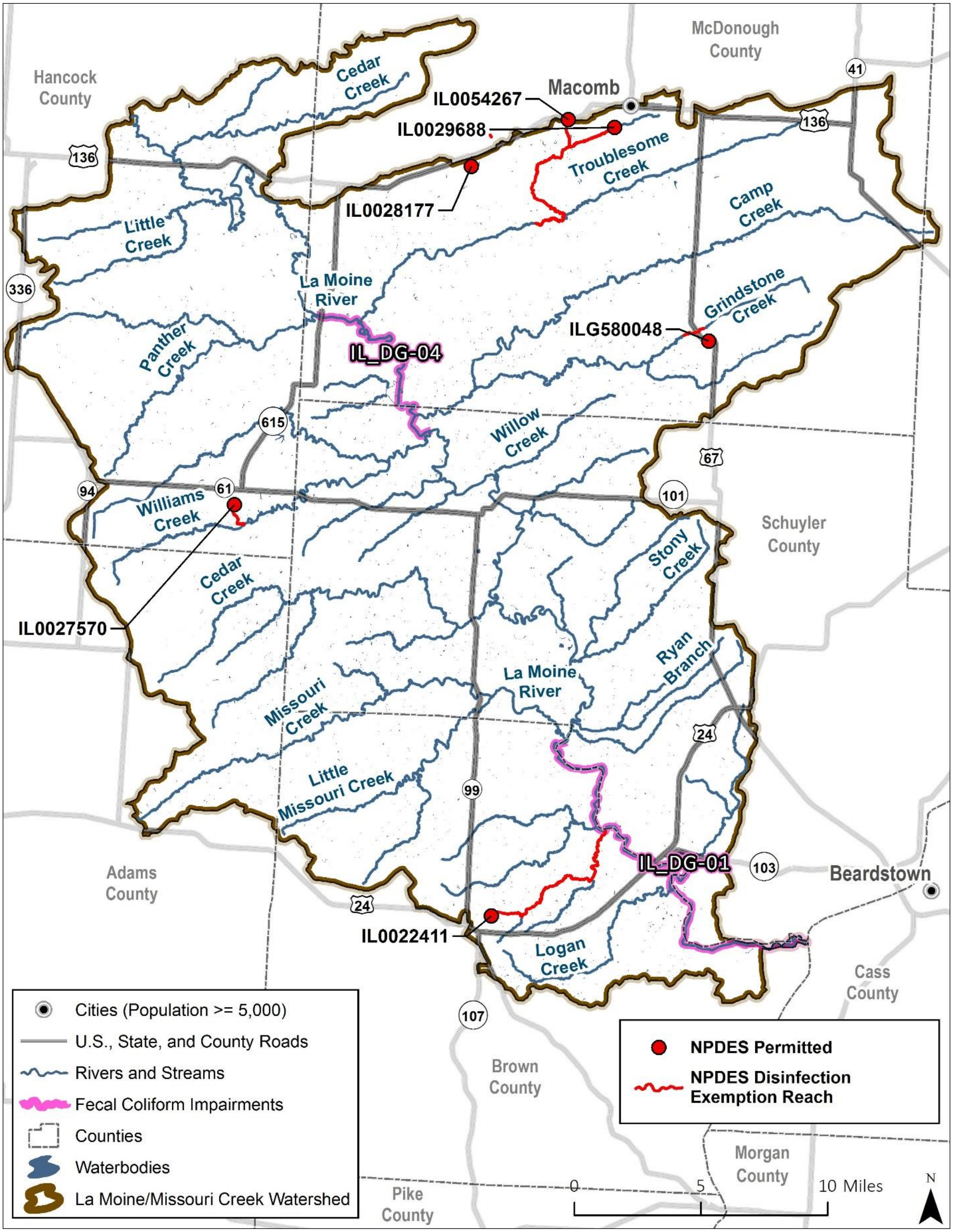

Figure 19. Disinfection exemption reaches.

7.4 Margin of Safety

The CWA requires that a TMDL include a margin of safety (MOS) to account for uncertainties in the relationship between pollutants loads and receiving water quality. U.S. EPA guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS). A 10 percent explicit MOS has been applied as part of this TMDL for fecal coliform. A moderate MOS was specified because the use of load duration curves is expected to provide accurate information on the loading capacity of the stream, but this estimate of the loading capacity may be subject to potential error associated with the method used to estimate flows. The MOS for fecal coliform is also implicit because the load duration analysis does not address die-off of pathogens.

7.5 Reserve Capacity

Reserve capacity (RC) is provided to those watersheds that are expected to further develop. For fecal coliform, any new or expanded discharges will be required to comply with permit limits. As long as the facility is meeting the single sample maximum and geomean standards, any new flow and associated load will be in compliance with the TMDL. No reserve capacity is set aside at this time.

7.6 Critical Conditions and Seasonality

The Clean Water Act requires that TMDLs take into account critical conditions for stream flow, loading, and water quality parameters as part of the analysis of loading capacity. Through the load duration curve approach it was determined that load reductions are needed for specific flow conditions; however, the critical conditions (the periods when the greatest reductions are required) vary by location and are inherently addressed by specifying different levels of reduction according to flow.

The allocation of point source loads (i.e., the WLA) also takes into account critical conditions by assuming that the facilities will always discharge at their design flows. In reality, many facilities discharge below their design flows.

The Clean Water Act also requires that TMDLs be established with consideration of seasonal variations. Seasonal variations are addressed in this TMDL by assessing conditions only during the season when the water quality standard applies (May through October) for fecal coliform. The load duration approach also accounts for seasonality by evaluating allowable loads on a daily basis over the entire range of observed flows and by presenting daily allowable loads that vary by flow.

8. Allocations

8.1 La Moine River (DG-01) Fecal Coliform TMDL

A fecal coliform bacteria TMDL has been developed for the La Moine River segment DG-01. Figure 20 presents the fecal coliform load duration curve and Table 27 and Table 28 summarize the TMDL and required reductions for both the single sample maximum standard and the geomean standard, respectively. Pollutant reductions are needed for all flow conditions, except mid-range and low flows, to meet the single sample maximum standard. A 58 percent reduction is needed to meet the geomean standard. Table 29 summarizes the individual WLAs.

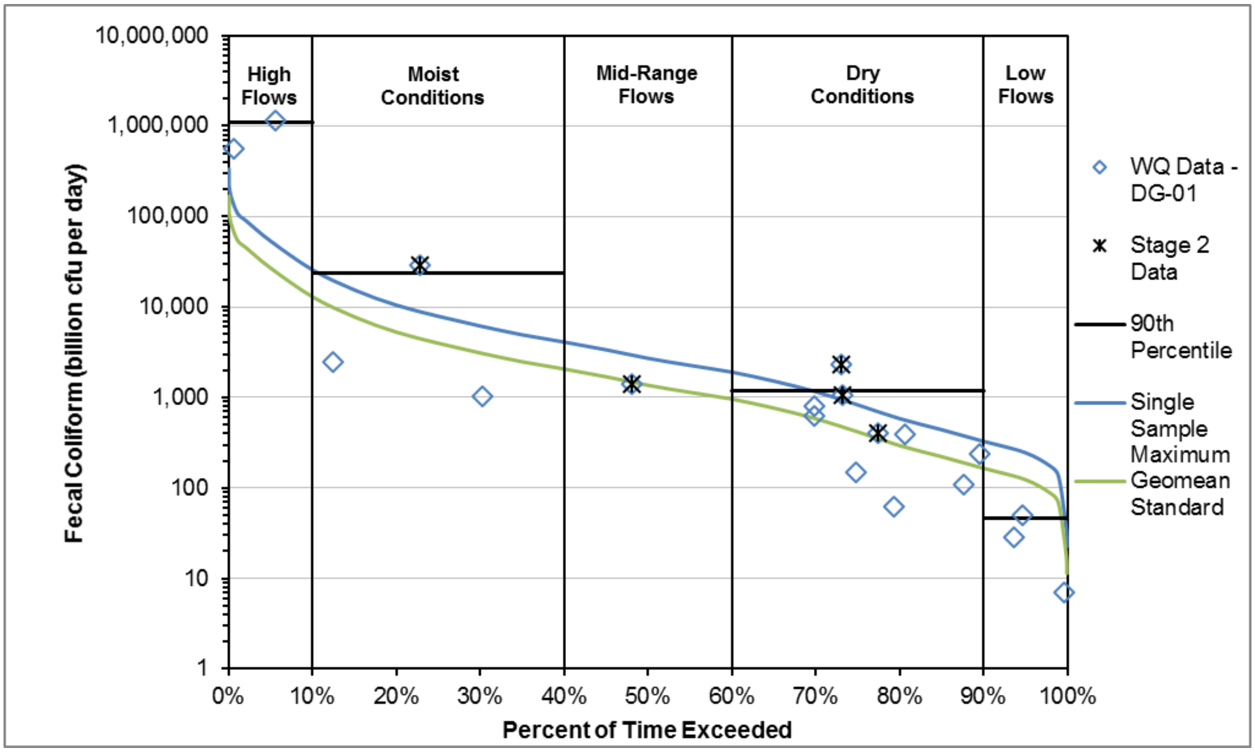

Figure 20. Fecal coliform load duration curve, La Moine River at DG-01.
Water quality data presented in the load duration curve were collected from 2011 to 2016.

Table 27. Fecal coliform TMDL summary (single sample maximum standard; La Moine River at DG-01)

TMDL Parameter		Flow Zones				
		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
		Fecal Coliform Load (billion cfu/day)				
Wasteload Allocation	NPDES-permitted facilities	140	57	57	57	57
	CAFO	0	0	0	0	0
Load Allocation		47,708	7,023	2,374	689	164
MOS		5,316	787	270	83	25
Loading Capacity		**53,165**	**7,866**	**2,701**	**829**	**246**
Existing Load		1,086,827	23,481	1,407	1,192	46
Load Reduction [a]		95%	66%	0%	30%	0%

a. TMDL reduction is based on the observed 90th percentile load in each flow regime

Table 28. Fecal coliform TMDL summary (geomean standard; La Moine River at DG-01)

TMDL Parameter		Flow Zones				
		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
		Fecal Coliform Load (billion cfu/day)				
Wasteload Allocation	NPDES-permitted facilities	70	29	29	29	29
	CAFO	0	0	0	0	0
Load Allocation		23,854	3,511	1,187	344	82
MOS		2,658	393	135	41	12
Loading Capacity		**26,582**	**3,933**	**1,351**	**414**	**123**
Geomean Concentration (# cfu/100 mL) [a]		474				
Geomean Reduction [b]		58%				

a. Geomean concentration of five samples collected by Illinois EPA in August 2016.

b. TMDL reduction is based on the 2016 observed geometric mean concentration and the geomean standard (200 cfu/100 mL).

Table 29. Individual fecal coliform WLAs, La Moine River at DG-01

Permit ID	Facility Name	Fecal Coliform WLA (billion cfu per day)					
		High Flow Conditions			Moist to Low Flow Conditions		
		Design Maximum Flow (MGD)	Single Sample Maximum Standard	Geomean Standard	Design Average Flow (MGD)	Single Sample Maximum Standard	Geomean Standard
IL0022411	Mt. Sterling, City of	0.54	8.2	4.1	0.366	5.5	2.8
IL0027570	Augusta STP	0.2325	3.5	1.8	0.093	1.4	0.7
IL0028177	Colchester, City of	0.47	7.1	3.6	0.17	2.6	1.3
IL0029688	Macomb, City of	7.5	113.6	56.8	3	45.4	22.7
IL0042153	Plymouth, Village of	0.3	4.5	2.3	0.06	0.9	0.5
IL0054267	Country Aire Estates MHP	0.0315	0.5	0.2	0.0126	0.2	0.1
ILG580048	Industry, Village of	0.1875	2.8	1.4	0.075	1.1	0.6
	Total		**140**	**70**		**57**	**29**

8.2 La Moine River (DG-04) Fecal Coliform TMDL

A fecal coliform bacteria TMDL has been developed for the La Moine River segment DG-04. Figure 21 presents the fecal coliform load duration curve and Table 30 and Table 31 summarize the TMDL and required reductions for both the single sample maximum standard and the geomean standard, respectively. Pollutant reduction is needed under all flow conditions, except under low flows to meet the single sample maximum standard. A 74 percent reduction is needed to meet the geomean standard. Table 32 summarizes the individual wasteload allocations.

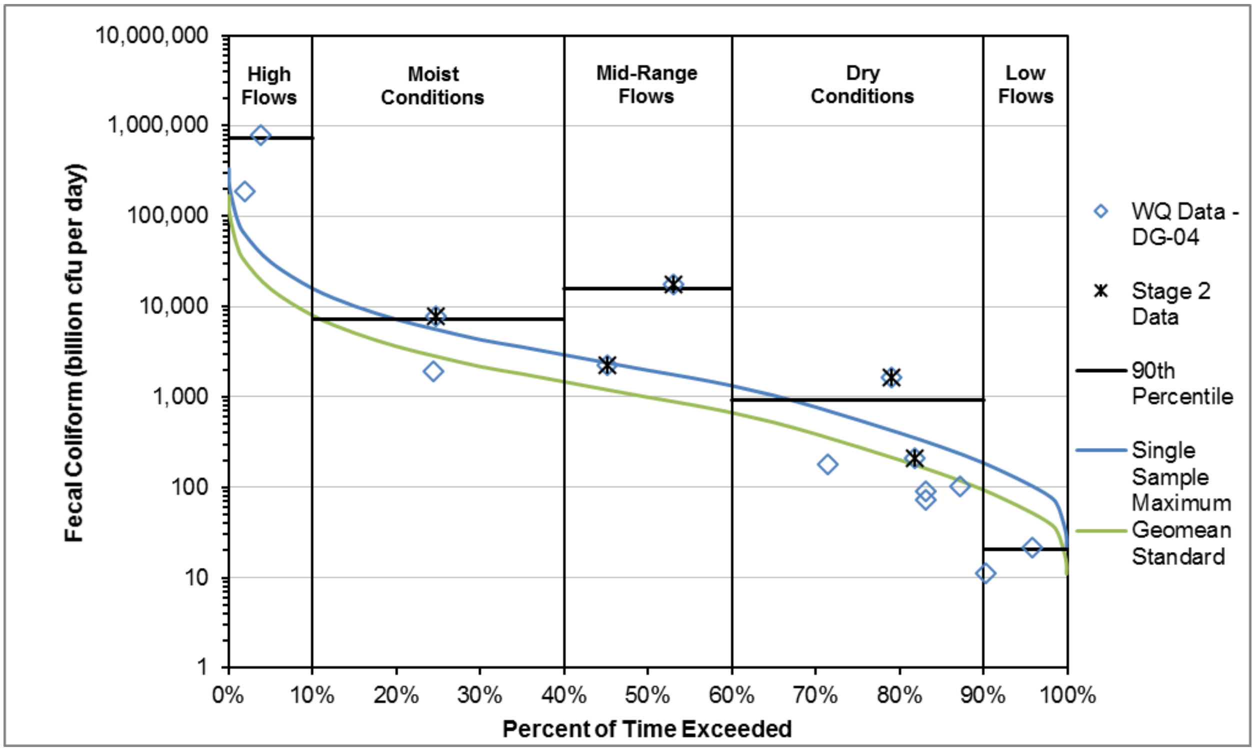

Figure 21. Fecal coliform load duration curve, La Moine River at DG-04.
Water quality data presented in the load duration curve were collected from 2011 to 2016.

Table 30. Fecal coliform TMDL summary (single sample maximum standard; La Moine River at DG-04)

TMDL Parameter		Flow Zones				
		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
		Fecal Coliform Load (billion cfu/day)				
Wasteload Allocation	NPDES-permitted facilities	132	52	52	52	52
	CAFO	0	0	0	0	0
Load Allocation		27,972	4,942	1,734	455	51
MOS		3,123	555	198	56	11
Loading Capacity		**31,227**	**5,548**	**1,983**	**563**	**114**
Existing Load		721,606	7,175	15,869	935	20
Load Reduction [a]		96%	23%	88%	40%	0%

a. TMDL reduction is based on the observed 90th percentile load in each flow regime

Table 31. Fecal coliform TMDL summary (geomean standard; La Moine River at DG-04)

TMDL Parameter		Flow Zones				
		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
		Fecal Coliform Load (billion cfu/day)				
Wasteload Allocation	NPDES-permitted facilities	66	26	26	26	26
	CAFO	0	0	0	0	0
Load Allocation		13,986	2,471	867	227	25
MOS		1,561	277	99	28	6
Loading Capacity		**15,613**	**2,774**	**992**	**281**	**57**
Geomean Concentration (# cfu/100 mL) [a]		782				
Geomean Reduction [b]		74%				

a. Geomean concentration of five samples collected by Illinois EPA in August 2016.

b. TMDL reduction is based on the 2016 observed geometric mean concentration and the geomean standard (200 cfu/100 mL).

Table 32. Individual fecal coliform WLAs, La Moine River at DG-04

Permit ID	Facility Name	Fecal Coliform WLA (billion cfu per day)					
		High Flow Conditions			Moist to Low Flow Conditions		
		Design Maximum Flow (MGD)	Single Sample Maximum Standard	Geomean Standard	Design Average Flow (MGD)	Single Sample Maximum Standard	Geomean Standard
IL0027570	Augusta STP	0.2325	3.5	1.8	0.093	1.4	0.7
IL0028177	Colchester, City of	0.47	7.1	3.6	0.17	2.6	1.3
IL0029688	Macomb, City of	7.5	113.6	56.8	3	45.4	22.7
IL0042153	Plymouth, Village of	0.3	4.5	2.3	0.06	0.9	0.5
IL0054267	Country Aire Estates MHP	0.0315	0.5	0.2	0.0126	0.2	0.1
ILG580048	Industry, Village of	0.1875	2.8	1.4	0.075	1.1	0.6
Total			**132**	**66**		**52**	**26**

9. Public Participation

A public meeting was held on October 25, 2016 at Macomb City Hall in Macomb, IL to present the Stage 1 report and findings. A public notice was sent out and the public comment period closed on November 25, 2016. Two sets of written comments were provide by the La Moine River Ecosystem Partnership. These comments are provided in Appendix A and updates have been made to the Stage 1 report to address these comments as appropriate.

Two questions were raised at the public meeting regarding water quality standards, these are discussed specifically below:

1. How are water quality standards developed in Illinois?

Water quality standards in Illinois are adopted and maintained by the Illinois Pollution Control Board. Any party may propose water quality standards for the Board to consider, but generally it is Illinois EPA that develops and proposes standards. Often the standards proposed by Illinois EPA come from National Criteria developed by U.S. EPA. Sometimes the proposed standards are developed in-state and are unique to Illinois. The development process is based on toxicity testing of aquatic organisms. Most water quality standards cover toxic substances and exist to protect aquatic life. Illinois EPA sometimes commissions toxicity testing through the Illinois Natural History Survey to aid in the development process.

2. Why was the manganese standard revised [between original listing of streams in the La Moine/Missouri Creek watershed as impaired and now]?

The federal Clean Water Act requires states to review water quality standards at least once every three years. The previous manganese water quality standard had been in place since 1972 when the Pollution Control Board was created. Illinois EPA researched the recent toxicity data of manganese to aquatic life and found that the water quality standard was extremely over protective. The new manganese standards were calculated from toxicity test data for organisms native to Illinois waters and were reviewed and approved by U.S. EPA. The current manganese water quality standard is protective of aquatic life without being over protective and likely to cause economic hardship. The public water supply standard for surface water intakes was also reviewed and it also was found to be overly restrictive. The research conducted to change this standard concerned the abilities of public water supply treatment plants to remove manganese in raw water. It was found that the treatment plants could function with somewhat higher manganese concentrations in the raw source water and have no diminishment of treatment.

<Additional information to be added following Stage 3 meetings>

10. Implementation Plan and Reasonable Assurance

The implementation plan identifies planned future activities and recommends additional activities that stakeholders could consider to reduce pollutant loads to meet the TMDL reductions and improve the conditions of the La Moine/Missouri Creek watershed. Not only will these implementation activities help to achieve the TMDL reductions and attain water quality standards, these activities will also result in a cleaner, healthier watershed for the people who depend on the resources for their livelihood now and in the future.

10.1 Introduction

This implementation plan is a framework that watershed stakeholders may use to guide implementation of best management practices (BMPs) to address TMDLs. This framework is flexible and incorporates an adaptive management framework to allow watershed stakeholders to adjust the implementation plan to align with their priorities. This flexibility is necessary because the implementation of nonpoint source controls is voluntary. Adaptive management is also necessary because factors unique to specific localities may yield better or worse results for a certain BMP (or suite of BMPs) and the implementation plan will need to be modified to account for such results. This implementation plan addresses bacteria TMDLs in waters of the La Moine/Missouri Creek watershed in Illinois. As discussed in Section 8 of this report, TMDLs were developed for fecal coliform to address impairments of the primary contact reaction use in two segments (Table 33 and Figure 22).

Table 33. Impaired waters with TMDLs

Name	Segment ID	Designated Uses	TMDL Parameters
La Moine River	DG-01	Primary contact recreation	Fecal coliform
	DG-04	Primary contact recreation	Fecal coliform

An important factor for implementation is access to technical and financial resources. This implementation plan identifies what type of technical and financial resources are needed to undertake the activities recommended for achieving the water quality goals in the watershed. One potential source of funding is the Clean Water Act Section 319 Nonpoint Source Management grants. Section 319 grant funding supports implementation activities including technical and financial assistance, education, training, demonstration projects, and monitoring to assess the success of nonpoint source implementation projects. To be eligible for these funds, watershed management plans must address nine elements identified by U.S. EPA (2008, 2013) as critical for achieving improvements in water quality. These nine elements are listed below:

1. Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve load reductions estimated within the plan
2. Estimate of the load reductions expected from management measures
3. Description of the nonpoint source management measures that will need to be implemented to achieve load reductions estimated in element 2; and identification of critical areas
4. Estimate of the amounts of technical and financial assistance needed, associated costs, and the sources and authorities (e.g., ordinances) that will be relied upon to implement the plan
5. An information and public education component; early and continued encouragement of public involvement in the design and implementation of the plan
6. Implementation schedule

7. A description of interim, measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented
8. Criteria to measure success and reevaluate the plan
9. Monitoring component to evaluate the effectiveness of the implementation efforts over time

The La Moine/Missouri Creek watershed TMDLs, including this implementation plan, is considered a watershed plan that meets U.S. EPA's nine elements. Applicable elements are listed in italics at the beginning of each corresponding section.

10.2 Fecal Coliform Sources

This section contains the requirements for U.S. EPA's ***element one*** *of a watershed plan: identification of causes of impairments and pollutant sources.*

Fecal coliform is causing impairment in two stream segments in the watershed (Figure 22). A description of fecal coliform sources is included in Section 3 and summarized in the following sections. Achieving water quality goals in the La Moine/Missouri Creek watershed will focus on addressing the primary sources of fecal coliform including:

- Livestock feeding operations
- Livestock with access to riparian areas
- Onsite wastewater treatment systems
- Municipal point source dischargers

These sources are contributing to impairments, and as such need to be managed in a way that will reduce pollutant loadings and address other negative effects. Nonpoint and point sources are described in this section, however only nonpoint sources are further evaluated as part of this implementation plan, in accordance with the intention of U.S. EPA nine element plans.

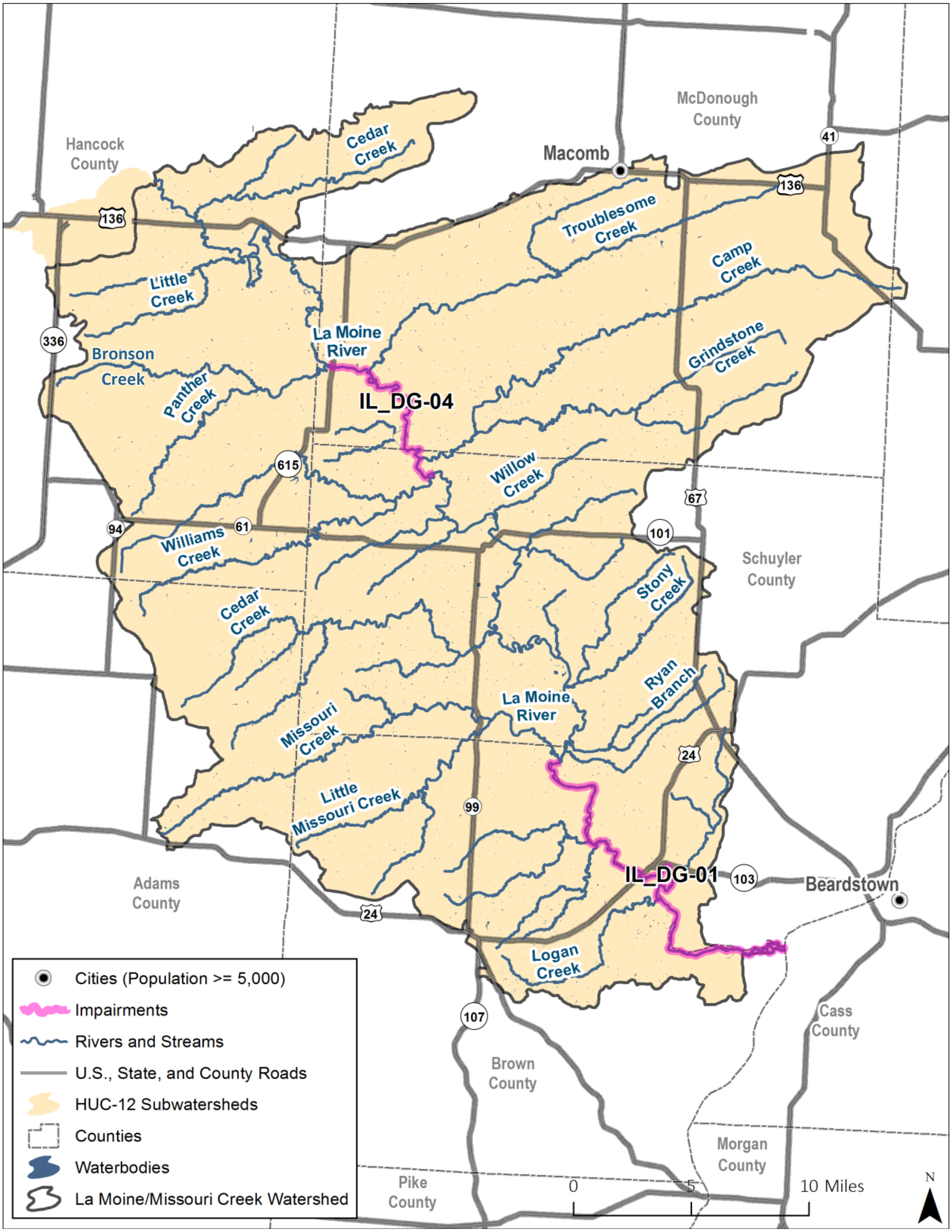

Figure 22. La Moine/Missouri Creek segments with fecal coliform TMDLs.

10.2.1 Nonpoint Sources of Fecal Coliform

Potential nonpoint sources of fecal coliform in the watershed are livestock (feedlots, access to streams, manure management), onsite wastewater treatment systems, and wildlife.

Livestock are a potential source of bacteria to streams, particularly when direct access is not restricted and where feeding structures are located near riparian areas. Cattle, poultry and hogs are the primary types of livestock in the impaired watersheds. Figure 23 summarizes the area weighted total animal unit per HUC12 in the watershed. Animal units were obtained from the U.S. EPA's *Spreadsheet Tool for the Estimation of Pollutant Load* (STEPL) database.

Conventional onsite wastewater treatment systems are composed of a septic tank and drainfield. Fecal coliform loading rates from appropriately sited and properly functioning systems are typically insignificant. However, if systems are placed on unsuitable soils, not maintained properly, or are connected to subsurface drainage systems, loading rates to receiving waterbodies may be relatively high.

In addition to the information provided in Section 3.3.3, county health departments were contacted a second time to ensure all available information regarding septic systems was included; no new information was available on septic system inventories or failure rates. The environmental divisions of county health departments in Illinois provide inspections of new and repaired onsite wastewater treatment systems. In addition, Fulton County health department conducts point of sale inspections when a property is bought and sold. The Illinois Department of Public Health regulates the installation of all septic tanks in the state. They review and approve plans for private and alternative sewage disposal systems before construction and also licenses or certifies contractors and trainees for private sewage disposal installation and maintenance.

Wildlife may also contribute to fecal coliform in the watershed. While no specific information is available on wildlife populations in the watershed, fecal matter from wildlife such as deer, raccoon, and waterfowl are other potential sources of fecal coliform to impaired streams. This may be especially true in wooded or agricultural areas with low densities of human population.

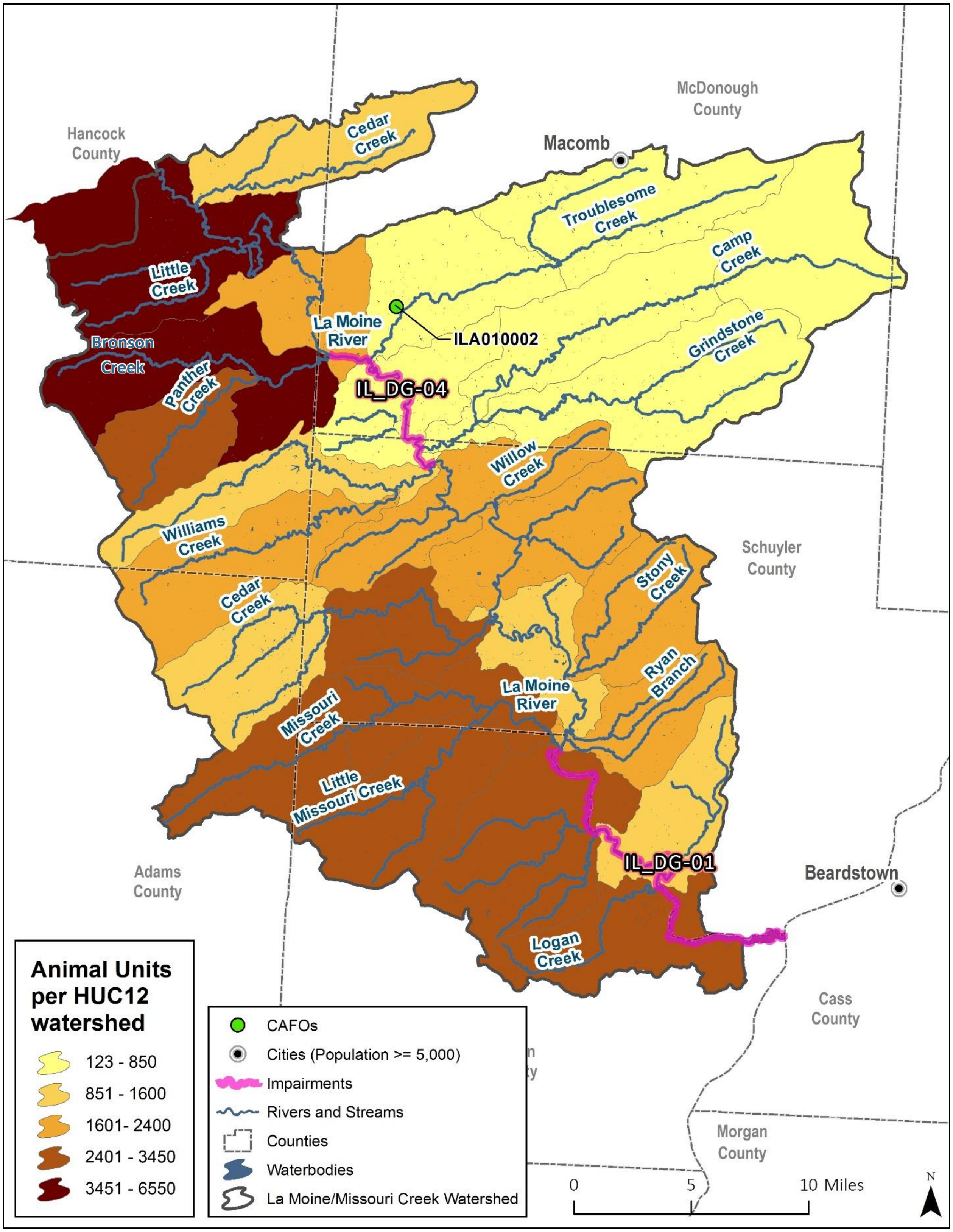

Figure 23. Total animal units by HUC12 from STEPL.

10.2.2 Point Source Dischargers

There are 11 individual facilities are covered by NPDES permits in the watershed; four of those facilities are not expected to discharge fecal coliform (see Table 11). The remaining permitted discharges are sewage treatment plants and may be contributing to impairments within the watershed, as discussed in Section 3.2. However, none of the facilities discharge directly to fecal coliform impaired segments. Discharge monitoring reports between 2013 and 2015 were reviewed to identify any permit exceedances for fecal coliform. Macomb (IL0029688) reported six exceedances of the fecal coliform standard; no other exceedances were identified. Unpermitted sanitary sewer overflows were reported for Colchester during 2015 and 2016. There is potential for unpermitted sanitary sewer overflows in Colchester, Macomb, and Mount Sterling.

Seven facilities have disinfection exemptions in the watershed which allow a facility to discharge wastewater without disinfection (Table 11). Facilities with disinfection exemption reaches discharging into an impaired segment may have their year-round disinfection exemption reviewed through future NPDES permitting actions. Monitoring requirements can be included as a condition in the NPDES permit upon renewal. Following this monitoring Illinois EPA can evaluate the need for point source controls through the NPDES permitting program. Specific to implementation, disinfection exemptions should be reviewed and evaluated as well as point source discharges of fecal coliform into the watershed.

There is also one CAFO in the La Moine/Missouri Creek watershed: Pinnacle Genetics (ILA010002). The facility is located within the Troublesome Creek watershed that drains to impaired segment DG-04.

10.3 Load Reductions and Best Management Practices

This section contains the requirements for U.S. EPA's ***element two:*** *Estimate of the load reductions expected from management measures*

Fecal coliform reductions are needed in two segments of the La Moine River (Table 34, see Section 8 for additional details). Because the percent load reductions needed to achieve the TMDLs are high, successful implementation will likely involve multiple BMPs targeting different sources in priority areas throughout the watersheds.

Within the watershed planning framework, candidate BMPs are identified and then evaluated to determine which will best address the causes and sources of pollutant loads. Table 35 includes a suite of BMPs that could be used to achieve necessary load reductions in the watershed. This table summarizes the expected pollutant removal efficiency (percent reduction) for each BMP, descriptions of each BMP follow. There are many different BMP scenarios that could be used to achieve pollutant load reductions, this plan provides one example.

Table 34. Load reductions needed in the La Moine/Missouri Creek watershed

Waterbody ID	Waterbody Name	TMDL Pollutant	Needed Reductions by Flow Zone				
			High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
DG-01	La Moine River	Fecal Coliform (SSM)	95%	66%	0%	30%	0%
		Fecal Coliform (GM)	58%				
DG-04	La Moine River	Fecal Coliform (SSM)	96%	23%	88%	40%	0%
		Fecal Coliform (GM)	74%				

SSM – based on the single sample maximum water quality standard GM – based on the geometric mean water quality standard

Table 35. Recommended BMPs for implementation

BMP	Fecal Coliform Removal Efficiency
Agricultural BMPs	
Riparian buffers and filter strips (NRCS 386, 390, 391, 393)	34-74% [a]
Exclusion fencing (NRCS 382, 578)	29-46% [b]
Feedlot BMPs (NRCS 362, 367, 558, 591, 632, 634, 635) (buffers, livestock access control, manure management plans, waste storage facilities and clean water diversions)	90-97% [b, c]
Onsite Wastewater BMPs	
Upgrading or replacing failing septic systems	100% for failing septics
Septic maintenance	100% for failing septics
Education and inspection programs	100% for failing septics

a. Source: Wenger 1999
b. Source: U.S. EPA 2003
c. Source: Meals and Braun 2006

10.3.1 Agricultural BMPs

Livestock and livestock manure are a potential source of bacteria to streams, particularly when direct access is not restricted and where feeding structures are located near riparian areas. Agricultural BMPs to address fecal coliform loading are presented in the following subsections and the estimated removal efficiencies (i.e., reductions) are summarized in Table 35. Other feedlot management practices can also be used to achieve the goals of the TMDL and this plan.

Riparian Buffers and Filter Strips

Riparian buffers are composed of vegetation that is tolerant of intermittent flooding and/or saturated soils located in the transitional zone between upland and aquatic habitats. Filter strips are a strip of permanent vegetation located between disturbed land (cropland or grazing) and environmentally sensitive areas (NRCS 2003, 2013). Riparian buffers and filter strips provide many of the same benefits and can effectively address water quality degradation from sediment and fecal coliform while enhancing habitat. Riparian buffers and filter strips that include perennial vegetation and trees can filter runoff from adjacent cropland, provide shade and habitat for wildlife, and reinforce streambanks to minimize erosion. The root structure of the vegetation used enhances infiltration of runoff and subsequent trapping of pollutants. Both, however, are only effective in this manner when the runoff enters the BMP as a slow moving, shallow "sheet"; concentrated flow in a ditch or gully, will quickly pass through the vegetation offering minimal opportunity for retention and uptake of pollutants. Similarly, tile lines can often allow water to bypass a buffer or filter strip, thus reducing its effectiveness. The Illinois NRCS electronic Field Office Technical Guide recommends the minimum width of a riparian buffer should be 2.5 times the width of the stream (at bank-full elevation) or 35 feet for water bodies to achieve additional water quality improvements (NRCS 2013). Whereas, sufficient filter strip widths are dependent on the slope of the land. Table 36 summarizes the minimum and maximum flow lengths for filter strips according to Illinois NRCS standards.

Table 36. Minimum and maximum filter strip length for land slope (NRCS 2003)

Slope (%)	0.5	1.0	2.0	3.0	4.0	5.0 or greater
Minimum (feet)	36	54	72	90	108	117
Maximum (feet)	72	108	144	180	216	234

Exclusion Fencing

To reduce bacteria from livestock with access to streams, the implementation plan goal is to promote the use of cost-share funding to voluntarily implement BMPs for alternative watering systems and exclusion fencing. These BMPs limit or eliminate livestock access to a stream or waterbody. Fencing can be used with controlled stream crossings to allow livestock to cross a stream while minimizing disturbance to the stream channel and streambanks. Providing alternative water supplies for livestock allow animals to access drinking water away from the stream, thereby minimizing the impacts to the stream and riparian corridor. Some researchers have studied the impacts of providing alternative watering sites without structural exclusions and found that cattle spend 90 percent less time in the stream when alternative drinking water is furnished (U.S. EPA 2003). U.S. EPA (2003) estimates that fecal coliform reductions from 29-46 percent can be expected; nutrient and sediment load reductions are also achieved.

Feedlot BMPs

Feedlots on livestock feeding operations has been identified as a potential source of fecal coliform. Proper management of runoff and waste is important to improving water quality in the watershed. Animal operations are typically either pasture-based or confined, or sometimes a combination of the two. The operation type dictates the practices needed to manage manure from the facility. A pasture or open lot system with a relatively low density of animals (1 to 2 head of cattle per acre [U.S. EPA 2003]) may not produce manure in quantities that require management for the protection of water quality. If excess manure is produced, then the manure will typically be scraped with a tractor to a storage bin constructed on a concrete surface. Stored manure can then be land applied at agronomic rates when the ground is not frozen and precipitation forecasts are low. Rainfall runoff should be diverted around the storage facility with berms or grassed waterways. Runoff from the feedlot area may contain pollutants and should be treated.

Confined facilities (typically dairy cattle, swine, and poultry operations) often collect manure in storage pits. Wash water used to clean the floors and remove manure buildup combines with the solid manure to form a liquid or slurry in the pit. The mixture is usually land applied or transported offsite.

Final disposal of waste usually involves land application on the farm or transportation to another site. Manure is typically applied to the land once or twice per year. To maximize the amount of nutrients and organic material retained in the soil, application should not occur on frozen ground or when precipitation is forecast during the next several days.

Storage of manure for at least 30 days prior to land application may reduce fecal coliform concentrations in runoff by 97 percent (Meals and Braun 2006). Use of waste storage structures, ponds, and lagoons reduce fecal coliform loading by 90 percent (U.S. EPA 2003). Anaerobic treatment in a lagoon or digester may reduce pathogen concentrations to 100 colony forming units per 100 milliliters in less than 15 days if temperatures are maintained at 35 ºC (Roos 1999). Livestock operation BMPs generally seek to contain manure and manure wastewater; contain and treat runoff contaminated with manure or manure wastewater; divert clean water; and prevent contaminated runoff following manure land application.

A watershed-wide feedlot inventory is recommended as an initial step in TMDL implementation to evaluate the effectiveness of existing feedlot management activities at reducing fecal coliform loading. In addition, the following BMPs are recommended for livestock feeding operations:

- **Manure management** (collection and storage; separation of solids and liquid/slurry)
  - Grading, earthen berms, and such to collect, direct, and contain manure
  - Installation of concrete pads
- **Runoff management** (runoff from production areas)
  - Grading, earthen berms, and such to collect and direct manure-laden runoff

    - Filter strips
    - Storage ponds
- **Clean water diversion**
    - Roof runoff management
    - Grading, earthen berms, and such to collect and direct uncontaminated runoff
- **Manure land application**
    - Nutrient management strategy (e.g., the 4Rs: **R**ight Source, **R**ight Rate, **R**ight Time, **R**ight Place)
    - Filter strips and grassed waterways

10.3.2 Onsite Wastewater Treatment Systems

BMPs to reduce fecal coliform loads from onsite wastewater treatment systems include maintenance, inspection programs, and public education. The most effective BMP for managing loads from septic systems is regular maintenance. U.S. EPA recommends that septic tanks be pumped every 3 to 5 years depending on the tank size and number of residents in the household (U.S. EPA 2002b). When not maintained properly, septic systems can cause the release of pathogens, as well as excess nutrients, into surface water. Annual inspections, in addition to regular maintenance, ensure that systems are functioning properly. An inspection program would help identify those systems that are currently connected to tile drain systems or storm sewers. Inspections would also help determine if systems discharge directly to a waterbody (“straight pipe”). Additional point of sale inspections, or inspections when a property is sold and purchased, can improve the baseline understanding of septic conditions and decrease occurrences of leaks potentially contributing to fecal loading in the watershed. These may include a soil boring to determine if the soil has adequate separation, and an examination of the inside of the tank after it has been pumped.

Education is a crucial component of reducing pollution from septic systems and can occur through public meetings, mass mailings, and radio and television advertisements. An inspection program can also help with public education because inspectors can educate owners about proper operation and maintenance during inspections.

The reductions in pollutant loading resulting from improved operation and maintenance of all systems in the watershed depends on the wastewater characteristics and the level of failure present in the watershed. The costs associated with education and inspection programs will vary depending on the level of effort required to communicate the importance of proper maintenance and the number of systems in the area.

10.4 Best Management Practices and Critical Areas

This section contains the remaining requirements for U.S. EPA’s ***element three:*** *description of nonpoint management measures needed to achieve load reductions and identification of critical areas.*

An important aspect of the implementation plan is to identify and encourage activities that can be implemented and produce measurable results. In many watersheds, implementation faces a variety of challenges. These challenges include how to assess the benefits of a variety of water quantity and quality control strategies, how to select the optimal combination of BMPs that minimize costs, how to be consistent with community goals and characteristics, and how to meet necessary reductions to achieve water quality standards. The following section will serve as a guide to overcome these challenges by identifying critical areas for BMP implementation and outlining the level of implementation needed.

10.4.1 Critical Areas for BMP Implementation

Successful implementation begins with identifying and focusing resources in critical areas. Critical areas are the focus of outcome-based plans because they represent those locations where project funding will provide the greatest environmental benefit.

As part of implementation plan development, a stream corridor land cover assessment was conducted throughout the watershed's 50-foot riparian zone (Figure 24; see Appendix A). The assessment categorized land cover on both sides of the stream and summarized the data by stream segment. Stream segments identified as critical areas for buffer restoration (less than 75 percent natural; identified as orange in Figure 24) include:

- South Fork Creek (IL DGGB and IL DGZF)
- West Creek (IL DGB-01)
- Clark Branch (IL DGEA)
- Grand Tower Branch (IL DGDC)
- Grindstone Creek (IL DGIA-03)
- Little Creek (IL DGMA)
- Camp Creek (IL DGI-01)
- Little Cedar Creek (IL DGGA)
- Willow Creek (IL DGZH)
- S Br, Cedar Creek So (IL DGGC)
- Troublesome Creek (IL DGJ-01)
- Killjordan Creek (IL DGJA-02)
- Prairie Creek (IL DGZN-01)
- Lewis Creek (IL DGZI
- Middle Creek (IL DGM)
- Mount Sterling Lake (IL RDN)

Critical areas for livestock BMPs are HUC12s with high densities of animal units (see Figure 23) within watersheds draining to impaired segments. Watersheds draining to impaired segments are provided in Table 37, critical areas are identified. All HUC12s within the La Moine/Missouri Creek watersheds are provided in Appendix B for reference.

Table 37. Watershed draining to impaired segments and critical areas for livestock BMPs

Impaired Segments	Watersheds Draining to Impaired Segment (HUC)	Critical Area
DG-01	West Creek-La Moine River (071300101202)	X
	Logan Creek-La Moine River (071300101204)	X
	Town Branch-La Moine River (071300101203)	
DG-04	Town of Plymouth-Bronson Creek (071300100402)	X
	Town of Plymouth-Bronson Creek (071300100402)	X
	Hogwallow Branch-La Moine Ruver (071300100704)	
	Rattlesnake Den Hallow-La Moine River (071300100703)	

As new information in the watershed project area becomes available (e.g., existing BMPs, their location within the appropriate critical area, and their pollutant reduction effectiveness), implementation can be adapted as needed. In addition, as new information becomes available as part of watershed planning projects, critical areas can be further refined to reflect site specific criteria.
Site specific critical areas can be developed from more detailed field-based observations and landowner involvement activities such as:

- Wind shield surveys
- Streambank surveys
- Farmer surveys
- Water quality monitoring
- Word of mouth and in-person conversations with local stakeholders and landowners

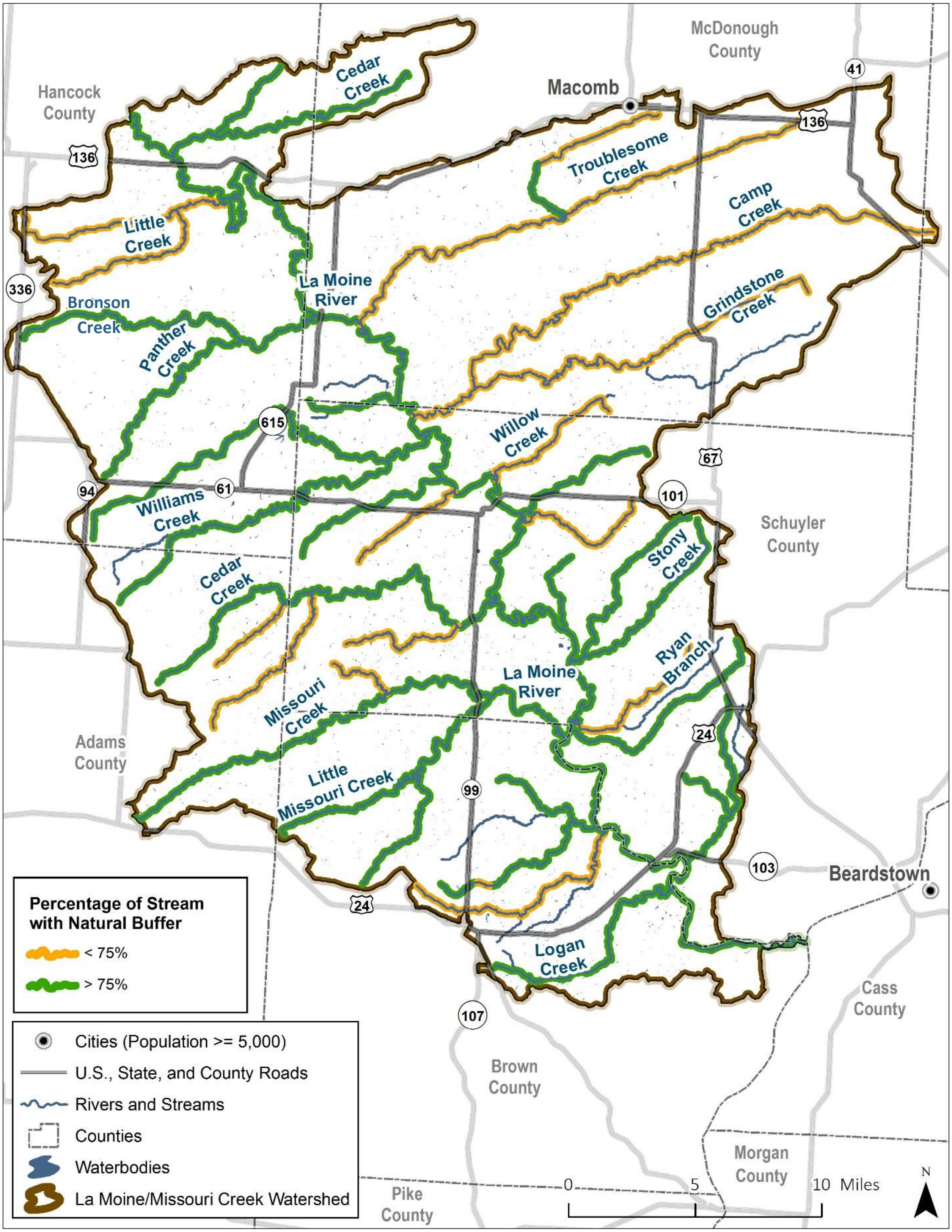

Figure 24. Results of stream corridor assessment. Critical areas for buffer restoration are those segments with <75% of natural cover.

10.4.2 Level of Implementation

Reduction in fecal coliform loading will require a combination of programmatic activities summarized in Section 10.3 that address septic systems and livestock. Fecal coliform source loads from BMPs in the watershed are estimated for select fecal coliform BMPs:

- **Riparian buffers and filter strips:** an estimated 34-74 percent reduction in fecal coliform has been estimated from the use of riparian buffers (Wenger 1999).
- **Livestock BMPs:** storage of manure for at least 30 days prior to land application may reduce fecal coliform concentrations in runoff by 97 percent (Meals and Braun 2006). Use of waste storage structures, ponds, and lagoons reduce fecal coliform loading by 90 percent (U.S. EPA 2003).
- **Exclusion fencing:** U.S. EPA (2003) estimates that fecal coliform reductions from 29-46 percent and be expected.

In addition, onsite wastewater BMPs can be used to reduce fecal coliform loading, however load reductions are not quantifiable.

Based on the above reductions, the following level of implementation is recommended to achieve necessary load reductions. It is important to note that the following implementation recommendations do not take into account existing BMPs on the landscape; these BMPs can be counted towards meeting load reduction requirements.

- **Livestock BMPs** implemented for approximately 4,365 animal units, or 60 percent of all animal units in watersheds draining to the La Moine (DG-01) impaired watershed, and on 5,483 animal units, or 75 percent of all animal units in watersheds draining to (DG-04). DG-04 requires a larger reduction in fecal coliform.
- **Riparian buffers and filter strips** on 75 percent of critical areas for buffer restoration (equal to 138 stream miles).
- **Exclusion fencing** on 75 percent of streams that are accessible to livestock.

Since exact fecal coliform loading reductions depend on a multitude of site specific factors, it is also recommended that implementation of onsite wastewater BMPs occurs in the watershed to ensure needed reductions are met. Both ambient water quality and BMP effectiveness monitoring throughout implementation will further refine and direct the level of BMP implementation needed to achieve necessary load reductions in the watershed.

10.5 Technical and Financial Assistance

This section contains the requirements for U.S. EPA's ***element four:*** *technical and financial assistance needed, associated costs, and the sources and authorities that will be relied upon for implementation.*

A significant portion of this TMDL implementation plan focuses on voluntary efforts as opposed to permit requirements. As a result, technical and financial assistance are essential to successful implementation over time. This section identifies sources of funding and technical assistance for the recommended implementation practices in the watershed. Selected BMPs will depend on numerous factors including cost, public support, and landowner interest. This section also identifies the watershed partners who will likely play a role in implementation.

10.5.1 Implementation Costs

Table 38 summarizes the estimated cost per recommended BMP.

Table 38. BMP costs

BMP	Cost/ unit
Agricultural BMPs	
Riparian buffers and filter strips (NRCS 386, 390, 391, 393)	\$60-400 /acre (herbaceous) [a] \$600-4,000 /acre (forested) [a]
Exclusion fencing (NRCS 382, 578)	\$0.9-12/ft [a]
Feedlot BMPs (NRCS 362, 367, 558, 591, 632, 634, 635) (buffers, livestock access control, manure management plans, waste storage facilities and clean water diversions)	\$350/animal unit [a]
Onsite Wastewater BMPs	
Upgrading or replacing failing septic systems	\$6,000 – 12,000 per system [b]
Septic maintenance	\$100-300 per system [b]
Education and inspection programs	Varies depending on level of effort required to communicate the importance of proper maintenance and the number of systems in the area.
Information and Education	
Information and Education strategy [c]	\$10,000/ year

a. Source: Estimated from EQIP 2017
b. Based on a review of local septic companies
c. See Section 10.6 for more information

10.5.2 Financial Assistance Programs

There are many existing financial assistance programs which may assist with funding implementation activities. Many involve cost sharing, and some may allow the local contribution of materials, land, and in-kind services (such as construction and staff assistance) to cover a portion or the entire local share of the project. Several of these programs are presented below. In addition to these programs, partnerships between local governments can help to leverage funds. State and federal grant programs may also be available, depending on the nature of the implementation activity.

Federal Programs

Environmental Quality Incentives Program (EQIP)
Several cost-share programs are available to landowners who voluntarily implement resource conservation practices. The most comprehensive is the NRCS EQIP which offers cost-sharing and incentives to farmers (in livestock, agricultural, or forest production) who utilize approved conservation practices to reduce pollutant loading from agricultural lands. In recent years, EQIP has provided cost-share for:

- Acreage of farmland that is managed under a nutrient management plan
- Use of vegetated filter strips
- Portions of the cost to construct grassed waterways, riparian buffers, and windbreaks
- Use of residue management
- Installation of drainage control structures on tile outlets, as well as portions of the cost of each structure

- Portions of the construction cost for a composting facility
- Portions of the fencing, controlled access points, spring and well development, pipeline, and watering facility costs
- Cost-share for waste storage facilities
- Prescribed grazing practices

To participate in the EQIP cost-share program, all BMPs must be constructed according to the specifications listed for each conservation practice. Payments are made after practices have been installed, and are capped per practice, but may cover up to 75 percent of project costs. Most contracts are for one to three years. More information about this program in Illinois is available at https://www.nrcs.usda.gov/wps/portal/nrcs/main/il/programs/financial/eqip/

Conservation Stewardship Program (CSP)

The NRCS CSP is for agricultural producers who want to enhance existing conservation practices on their land. NRCS consults one-on-one with the producer to develop enhancements that will improve conservation. CSP contracts are for 5 years and are renewable. Program participants are required to maintain the stewardship level that the resource concerns are already meeting in addition to meeting or exceeding at least one additional resource concern in each land use by the end of the contract. If a participant wishes to renew, the original contract must be fulfilled and the participant must agree to achieve additional conservation objectives. Two types of contract payments are available: payments to maintain existing conservation (based on the operation type and number of resource concerns meeting the applicable stewardship level at the time of application), and payments to implement additional conservation activities. There is a minimum annual payment of $1,500. Recent CSP conservation practices include:

- Riparian buffers
- Cover crops
- Livestock access management to streams

More information about the CSP can be found at https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/.

Agricultural Conservation Easement Program

NRCS's Agricultural Conservation Easement Program offers landowners the opportunity to protect, restore, and enhance agricultural lands and wetlands on their property. Land can be placed into an agricultural land easement or wetland reserve easement. Under the Agricultural Land component, NRCS may contribute up to 50 percent of the fair market value of the agricultural land easement. Under the Wetlands component, NRCS may contribute up to 100 percent of easement value for the purchase of the easement and up to 100 percent for the cost of restoration, and NRCS offers technical support for restoration. Easements can be 30 years in length or permanent. This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection. More information is available at http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/easements/acep/.

Tax Incentive Filter Strip Program

The is an NRCS program that protects water quality by providing a property tax reduction incentive to landowners who install vegetative filter strips between farm fields and a waterbody to be protected. As an incentive for installing protective vegetative filter strips on land adjacent to surface or ground water sources, landowners may receive a reduced property tax assessment of 1/6th of its value as cropland. Landowners can expect to save about $1 to $25 per acres in taxes depending on soils and local tax rates.

Vegetative filter strip design and certification assistance is available from local Soil and Water Conservation District offices. For more information, see local SWCD websites.

Conservation Reserve Program

The Farm Service Agency of the USDA supports the Conservation Reserve Program which provides a yearly rental payment in exchange for farmers removing environmentally sensitive land from agricultural production. Payments are based on the number of acres removed, and are capped at $50,000 per year. The land is converted to grass or forestland for the purposes of reducing erosion and protecting sensitive waters. This program is available to farmers who establish wetland or riparian buffers, vegetated filter strips, grassed waterways, or similar practices. The program also provides up to 50 percent of the upfront cost to establish vegetative cover, and contracts in the program are for 10 to 15 years. More information about this program can be found at https://www.dnr.illinois.gov/conservation/CREP/Pages/default.aspx.

Conservation Reserve Enhancement Program (CREP)

CREP is an enhancement of the Conservation Reserve Program. It is a Federal, State and Local partnership. Under the CREP, producers and private landowners are paid an annual rental rate in exchange for removing their frequently flooded and environmentally sensitive land from production and placing them under conservation practices. These practices reduce sediment and nutrients, improve water quality, and create/enhance critical habitat for fish and wildlife in Illinois. Eligible land meets one or more of the following criteria:

- Located in the 100-year floodplain
- Qualifies as wetlands, wetlands farmed under natural conditions, or prior converted wetlands
- Highly erodible land with an erodibility index of 8 or greater adjacent to the 100-year floodplain

Participation in the program is voluntary, and the contract periods for easements in Illinois are 15, 35 and perpetuity. More information on CREP in Illinois can be found at https://www.dnr.illinois.gov/conservation/CREP/Pages/default.aspx.

Sustainable Agricultural Grand Program

The Sustainable Agricultural Grand Program is a USDA program that funds research, education, and outreach efforts for sustainable agricultural practices. Farmer Rancher Grants are for farmers and ranchers who want to explore sustainable solutions to problems through on-farm research, demonstration, and education projects. These grants have funded a variety of topics including pest/disease management, crop and livestock production, education/outreach, networking, quality of life issues, marketing, soil quality, energy, and more. Awards are for a maximum of $7,500 for an individual project to a maximum of $22,500 for a group project, and may last up to 24 months. No matching funds are required for this program. About 40 Farmer Rancher grant projects are funded nationwide each year. More information is at http://www.sare.org/Grants.

State Revolving Fund

The State Revolving Fund programs, including the Water Pollution Control Loan Program for wastewater and stormwater projects and the Public Water Supply Loan Program for drinking water projects, are annually the recipients of federal capitalization funding, which is combined with state matching funds and program repayments to form a perpetual source of low interest financing for environmental infrastructure projects. Eligible projects include traditional pipe, storage, and treatment systems, green infrastructure projects, erosion and sediment control projects, and right-of-way acquisition needed for such projects. The loans are for a maximum of 20 years, and can be used to cover the entire project cost. More information about this fund can be found at http://www.epa.illinois.gov/topics/grants-loans/state-revolving-fund/index.

State Programs

Partners for Conservation (formerly Conservation 2000)
In 1995 the Illinois General Assembly passed the Conservation 2000 bill providing $100 million in funding over a 6-year period for the promotion of conservation efforts. In 1999, legislation was passed to extend the program through 2009. In 2008, House Bill 1780 was signed into law as Public Act 95-0139, extending the program to 2021 as Partners for Conservation. The Partners for Conservation Program funds programs at Illinois Department of Natural Resources, Illinois Department of Agriculture, and Illinois EPA. Its programs include:

- **Conservation Practices Program:** This program provides monetary incentives for conservation practices implemented on land eroding at a rate of one and one-half times or more the tolerable soil loss rate. Payments of up to 60% of initial costs are paid through the local conservation districts, which also prioritize and select the projects to be funded in their district. The program provides cost share assistance for BMPs such as cover crops, filter strips, grassed waterways, no-till systems, pasture planting, and contour farming. Practices funded through this program must be maintained for at least 10 years. More information can be found at https://www.agr.state.il.us/conservation/.
- **Streambank Stabilization Restoration Program**: Partners for Conservation also funds a streambank stabilization and restoration program aimed at restoring highly eroding streambanks. Research efforts are also funded to assess the effectiveness of vegetative and bioengineering techniques for bank stabilization. Streambank stabilization projects funded through this program must be maintained for at least 10 years. Further information is available at https://www.agr.state.il.us/conservation/.
- **Sustainable Agriculture Grant Program:** This program funds on-farm and university research, education, and outreach efforts for sustainable agricultural practices. Private landowners, organizations, and educational and governmental institutions are all eligible for participation in this program. Maximum per-project, per-year grant amounts are $10,000 for individuals and $20,000 for units of government, non-profits, institutions or organizations, and a source of matching funds is required. More information can be found at https://www.agr.state.il.us/conservation-2000.

Nonpoint Source Management Program
Illinois EPA receives federal funds through section 319(h) of the Clean Water Act to help implement Illinois' Nonpoint Source Pollution Management Program. The purpose of the program is to work cooperatively with local units of government and other organizations toward the mutual goal of protecting the quality of water in Illinois by controlling nonpoint source pollution. The program emphasizes funding for implementing cost-effective corrective and preventative BMPs on a watershed scale; funding is also available for BMPs on a non-watershed scale and the development of information/education nonpoint source pollution control programs.

The maximum federal funding available is 60 percent, with the remaining 40 percent coming from local match. The program period is two years unless otherwise approved. This is a reimbursement program. Funding is directed toward activities that result in the implementation of appropriate BMPs for the control of nonpoint source pollution or to enhance the public's awareness of nonpoint source pollution. Priorities include the development of watershed-based plans and implementation of those plans. Approximately $3,000,000 is available in this program per year Applications are accepted June 1 through August 1 of each year.

Ag Invest Agricultural Loan Program – Annual or Long Term

The Ag Invest Agricultural Loan Program offered through the Illinois State Treasury office provides low-interest loans to assist farmers. Loan funds can be used to implement soil and water conservation practices, for construction related expenses, to purchase farm equipment, or to pay for costs related to traditional crop production and alternative activities. Loan limits are between $300,000 and $400,000 per year. More information is available at http://illinoistreasurer.gov/Individuals/Ag_Invest.

Other Programs

Illinois Buffer Partnership

The Illinois Buffer Partnership is administered by Trees Forever, an Iowa non-profit organization. It offers cost sharing for installation of streamside buffer plantings at selected sites. Ten to twenty participants in Illinois are selected for the program annually. They receive cost-share assistance, onsite assistance from Trees Forever field staff, project signs and the opportunity to host a field day to highlight their project. Participants are reimbursed up to $2,000 for 50 percent of the expenses remaining after other grant programs are applied. Types of conservation projects eligible for the Illinois Buffer Partnership program include: riparian buffers, livestock buffers, streambank stabilization projects, wetland development, pollinator habitat, rain gardens and agroforestry projects. More information can be found at http://www.treesforever.org/Illinois_Buffer_Partnership.

10.5.3 Partners

There are several key implementation partners that can provide technical and financial assistance to promote successful watershed management. In addition, watershed groups have local knowledge of the resources and the residents. These federal, state, and local partners will have a more specific understanding of what technical and financial needs exist in the watershed to undertake the recommended implementation activities:

- La Moine River Ecosystem Partnership
- The La Moine River Watershed Partnership
- Resource Conservation and Development Areas (Two Rivers and Prairie)
- Prairie Land Conservancy
- Soil and water conservation districts (SWCDs)
- Illinois Farm Bureau
- University of Illinois Extension
- County health departments
- County commissioners, city councils, and township boards
- Illinois Environmental Protection Agency
- Illinois Department of Agriculture
- Illinois Department of Natural Resources
- Illinois State Water Survey
- National Resources Conservation Service
- Farm Service Agency
- U.S. EPA Region 5

Staff at local NRCS offices and county SWCDs can meet with farmers and landowners and help them identify, finance, and install or implement agricultural BMPs. Similarly, staff at county health departments can meet with septic system owners and help determine if and when upgrades are needed.

10.6 Public Education and Participation

*This section contains the requirements for U.S. EPA's **element five** of a watershed plan: information and education component.*

Successful implementation will rely heavily on effective public education and outreach activities that will encourage participation and produce changes in behavior. Although Section 319 grant funds and cost-share dollars are available, if watershed stakeholders eligible to participate in activities such as feedlot improvements are not aware of these programs or willing to get involved, water quality improvements will not occur in the watershed. This section presents recommendations related to developing and implementing a coordinated watershed-wide information and education strategy.

The information and education strategy should be spearheaded by a single entity serving as an outreach campaign organizer. Existing organizations could potentially lead this effort. The information and education strategy should include the following elements, many are included in this implementation plan:

- Goals and objectives
- Target audiences
- Programs, tools, materials, actions and campaigns
- Delivery mechanisms
- Priorities and schedule
- Lead and supporting organizations
- Expected outcomes and/or changes
- Estimated costs

The lead would be responsible for coordinating all outreach efforts conducted by multiple partners to ensure an efficient use of resources, avoid duplicative activities, and promote targeted messaging to specific audiences. In addition, stakeholder input should be considered and inform future management decisions, keeping in line with the adaptive management framework.

It is imperative to raise stakeholders' awareness about issues in the watershed and develop strategies to change stakeholders' behavior in a manner that will promote voluntary participation. Changes in awareness and behavior are surrogate indicators for longer-term changes in water quality. For example, if more feedlot operators are aware of cost-share programs and participation in these programs go up, local partners can report on this increased level of implementation and estimated load reductions.

A stakeholder survey could be another initial activity related to a watershed-wide information and education strategy. This type of survey (e.g., a pre-campaign survey) will help to establish a baseline of stakeholder awareness and behaviors that will help watershed outreach campaign organizers to further develop tailored outreach messages. Key topics for education and outreach could include:

- General watershed management principles
- Watershed friendly riparian uses and activities
- Agricultural BMP demonstration field days (e.g., cover crops, conservation tillage)
- Municipal operations
- Septic system maintenance and compliance
- Feedlot and livestock management
- Funding and technical assistance opportunities

Keeping in line with the adaptive nature of a nine element plan, results from stakeholder input should inform any changes or adaptations to the implementation plan. For example, if after engaging with local producers, watershed organizers realize that one of the recommended BMPs is unfeasible for the vast majority of the watershed, implementers of the plan should revisit and re-evaluate potential BMPs for the area.

The information and education strategy can include a variety of activities including newspaper articles, social media campaigns, newsletters, radio spots, website content, workshops, demonstration projects and tours. A variety of activities can be undertaken in order to reach the various stakeholders and should address each audience appropriately. Resources for information and education in the watershed are available to assist with promoting implementation activities and increasing awareness of water quality issues in the area. Examples of these resources are included below.

Illinois Manure Share

Created by the University of Illinois Extension, Illinois Manure Share is a free manure exchange program between livestock owners who have excess manure and those looking for organic material to use for gardening or landscaping. Its goal is to remove the manure from farms that do not have the acreage to adequately utilize its nutrients on their fields or pastures, benefiting water quality by both reducing nutrient runoff and lowering the amount of commercial fertilizer used by gardeners. For more information visit: http://web.extension.illinois.edu/manureshare/

Animal Agricultural Discussion Group

The Animal Agricultural Discussion Group is an informal and iterative group of individuals from the USDA, all sectors of the animal feeding industry and their association, academia, and states, formed by the U.S. EPA. The goal of the group is to develop a shared understanding of how to implement the Clean Water Act through open communication and improved two-way understanding of viewpoints. The group convenes via conference calls and face-to-face meetings twice per year.For more information or to join, visit https://www.epa.gov/npdes/animal-feeding-operations-afos-animal-agriculture-industry-partnerships.

University of Illinois Extension Units

The University of Illinois Extension has several units within the La Moine/Missouri Creek watershed. Each unit has extensive education and outreach programs in place that range in topic from commercial agriculture, horticulture, energy, and health that can provide meaningful resources to the information and education effort in the watershed. The main units include

- Adams-Brown-Hancock-Pike-Schuyler Extension Unit (http://web.extension.illinois.edu/abhps/)
- Henderson-Knox-McDonough-Warren Extension Unit (http://web.extension.illinois.edu/hkmw/)
- Fulton-Mason-Peoria-Tazewell Extension Unit (http://web.extension.illinois.edu/fmpt/).

10.7 Schedule and Milestones

This section contains the requirements for U.S. EPA's element ***six and seven*** *of a watershed plan: implementation schedule and a description of interim measurable milestones.*

A key part of U.S. EPA's nine elements is interim milestones that provide meaningful evaluation points and a focus for program activities. Interim milestones are steps that demonstrate that implementation measures are being executed in a manner that will ensure progress over time. Milestones are not changes in water quality. Measurable milestones are an important tool for directing limited resources towards the array and number of sources and nonpoint source pollution problems across the watershed. Interim measurable milestones are presented in Table 39.

A 25-year implementation schedule is assumed and divided into three phases: 2018-2022, 2023-2032, and 2033-2042. Each phase will rely on an adaptive management approach, and will build upon previous phases. Short-term efforts (Year 1-5) include implementing practices in critical areas. Mid-term efforts

(Year 6-15) are intended to build on the results of short-term implementation activities. This includes evaluating the success of Phase 1 projects installed (success rate, BMP performance, pollutant reductions realized, actual costs, etc.). Long-term efforts (Year 16-25) are those implementation activities that result in the watershed reaching full pollutant load reductions.

Table 39. Implementation schedule and interim milestones

Watershed	BMP	Milestones [a]		
		2018-2022	2023-2032	2033-2042
All fecal coliform impaired watersheds	Exclusion fencing (with alternative watering systems)	Inventory of livestock access to streams in watersheds draining to fecal coliform impaired streams, complete 4 fencing projects	Complete fencing projects on 30% of streams identified in inventory.	Complete fencing projects on 75% of streams identified in inventory.
	Riparian Buffers and Filter Strips	28 stream miles of critical areas for buffer restoration. Critical areas for buffer restoration identified in section 10.4.1	92 stream miles of critical areas for buffer restoration	138 stream miles of critical areas for buffer restoration
	Onsite wastewater BMPs	Landowner survey and inventory of failing systems in watersheds draining to fecal coliform impaired streams Develop program that increases inspections and upgrades Develop and distribute watershed-specific promotional material	Evaluate effectiveness of promotional material Update and continue distribution of promotional material Upgrade/replace 25% of failing septic systems in watersheds draining to fecal coliform impaired streams	Evaluate effectiveness of promotional material Update and continue distribution of promotional material Upgrade/replace 100% of failing septic systems in watersheds draining to fecal coliform impaired streams
	Information and Education	Assign lead organization and develop information and education strategy Stakeholder survey (“pre-campaign survey”) Identify priorities Begin implementation in critical areas identified in section 10.4.1	Continued implementation of information and education strategy with targeted audiences Interim stakeholder survey to evaluate effectiveness of strategy Adapt strategy, as needed	Implement changes, if needed Post campaign survey
La Moine River (DG-01)	Livestock BMPs	Livestock inventory and feedlot inspections beginning in critical areas 1,100 animal units under feedlot management beginning in critical areas Critical areas identified in section 10.4.1	3,640 animal units under feedlot management within watersheds draining to fecal coliform impaired streams	4,365 animal units under feedlot management within watersheds draining to fecal coliform impaired streams
La Moine River (DG-04)	Livestock BMPs	Livestock inventory and feedlot inspections beginning in critical areas identified in section 10.4.1 1,100 animal units under feedlot management beginning in critical areas identified in section 10.4.1	3,650 animal units under feedlot management within watersheds draining to fecal coliform impaired streams	5,483 animal units under feedlot management within watersheds draining to fecal coliform impaired streams

a. Milestones are cumulative

10.8 Progress Benchmarks and Adaptive Management

This section contains the requirements for U.S. EPA's ***element eight*** *of a watershed plan: a set of criteria that can be used to determine whether loading reductions are being achieved over time.*

Implementation activities occur in three phases using outcome-based strategic planning and an adaptive management approach. Phase 1 (2018-2022), Phase 2 (2023-2032), and Phase 3 (2033-2042) are designed to build on results from the preceding phase(s). To guide plan implementation through each phase using adaptive management, water quality benchmarks are identified to track progress towards attaining water quality standards. Progress benchmarks (Table 40) are intended to reflect the time it takes to implement management practices, as well as the time needed for water quality indicators to respond.

Table 40. Progress benchmarks

Indicator	Target	Segments	Timeframe	Progress benchmark
Fecal coliform	400 cfu/100 mL in <10% of samples and geometric mean <200 cfu/100 mL [a]	La Moine River (IL_DG-01) La Moine River (IL_DG-04)	2018-2022	20% of load reductions specified in Section 8
			2023-2032	40% of load reductions specified in Section 8
			2033-2042	Load reductions specified in Section 8 Full attainment of water quality standards

Notes
cfu/100 mL = colony forming units per 100 milliliters; mg/L = milligrams pwer liter; TMDL = total maximum daily load;
a. Fecal coliform targets are only applicable during the Illinois recreation season (May through October). Ten percent or less of samples collected in a 30-day period must be less than or equal to 400 cfu/100 mL. Geometric mean based on minimum of 5 samples taken over not more than a 30-day period.

To ensure management decisions are based on the most recent knowledge, the implementation plan follows the form of an adaptive and integrated management strategy and establishes milestones and benchmarks for evaluation of the implementation program. U.S. EPA (2008) recognizes that the processes involved in watershed assessment, planning, and management are iterative and that actions might not result in complete success during the first or second cycle. For this reason, it is important to remember that implementation will be an iterative process, relying upon adaptive management.

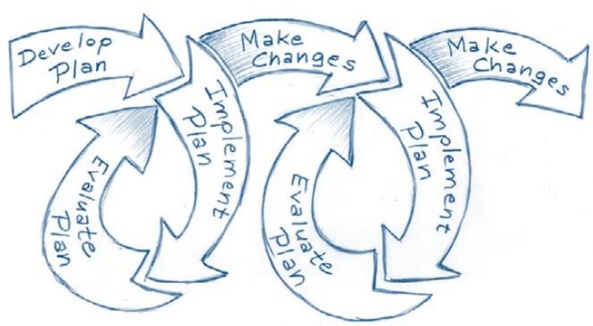

Figure 25. Adaptive management iterative process (U.S. EPA 2008).

Adaptive management is a commonly used strategy to address natural resource management that involves a temporal sequence of decisions (or implementation actions), in which the best action at each decision point depends on the state of the managed system. As a structured iterative implementation process, adaptive management offers the flexibility for responsible parties to monitor implementation actions, determine the success of such actions and ultimately, base management decisions upon the measured results of completed implementation actions and the current state of the system. This process, depicted in Figure 25, enhances the understanding and estimation of predicted outcomes and ensures refinement of necessary activities to better guarantee desirable results. In this way, understanding of the resource can be enhanced over time, and management can be improved.

In addition to focusing future management decisions, with established assessment milestones and benchmarks, adaptive management can include a re-assessment of the TMDL. Re-assessment of the TMDL is particularly relevant when completion of key studies, projects or programs result in data showing load reductions or the identification/quantification of alternative sources.

Reopening/reconsidering the TMDL may include refinement or recalculation of load reductions and allocations. For instance, if special studies can quantify wildlife loading, the load allocations can be refined and wasteload adjusted accordingly.

The implementation phases, milestones, and benchmarks will guide the adaptive management process, helping to determine the type of monitoring and implementation tracking that will be necessary to gauge progress over time. Evaluation for adaptive management can include a variety of evaluation components to gain a comprehensive understanding of implementation progress. An implementation evaluation determines if non-structural and structural activities are put in place and maintained by implementation partners according to schedule; this is often referred to as an output evaluation. An outcome evaluation focuses on changes to behaviors and water quality as a result of implementation actions. This type of evaluation looks at changes in stakeholder behavior and awareness, BMP performance, and changes to ambient water quality.

10.9 Follow-Up Monitoring

This section contains the requirements for U.S. EPA's ***element nine*** *of a watershed plan: a monitoring component to evaluate the effectiveness of the implementation efforts over time.*

The ultimate measure of success will be documented changes in water quality, showing improvement over time (see Table 40 for progress benchmarks). The top priority for this plan is to identify and reduce sources of fecal coliform that contribute to water quality impairments in the watershed. In addition, long-term monitoring of the overall health and quality of the watershed is important. Monitoring will help determine whether the implementation actions have improved water quality. In addition, monitoring will help determine the effectiveness of various BMPs and indicate when adaptive management should be initiated. The primary goal of the monitoring plan is to assess the effectiveness of source reduction strategies for attaining water quality standards and designated uses.

10.9.1 Water Quality Monitoring

Progress towards achieving water quality standards will be determined through ambient monitoring by Illinois EPA. The state conducts studies of ambient conditions across the state by evaluating watersheds on a rotating basis, collecting measurements of physical, chemical, and biological parameters. This ambient monitoring program will continue as the watershed plan is implemented with a particular focus on impaired sites. In addition to the ambient monitoring program conducted by Illinois EPA, across the state, wastewater treatment facilities also conduct water quality monitoring. Water quality monitoring efforts may also be supporting through volunteer citizen monitoring efforts that typically allow for more frequent monitoring at a lower cost. Formation of a monitoring committee may help streamline efforts.

Recommended monitoring in the watershed includes collection of chemical and flow data. At a minimum, in order to track changes in water quality in impaired streams, fecal coliform should continue to be monitored along each impaired stream segment for compliance with the single sample maximum and geomean standards. Increased frequency of monitoring will further allow additional evaluation of sources. Synoptic stream sampling can be used to identify hot spots, or additional critical areas in the impaired streams.

Sampling during different flow regimes is also critical to understanding sources. Monitoring flow is also recommended for each site when water quality samples are taken. Very low flow conditions can be found throughout the watershed, documenting when streams have zero or close to zero flow is also relevant to understanding sources and impairment status.

10.9.2 Microbial Source Tracking

Sources of bacteria are widespread and often intermittent. Some sources pose a greater risk to human health than others. Understanding the different source contributions and their potential risk to human health is important to overall TMDL implementation and prioritizing implementation activities that address the recreational use impairments due to fecal coliform.

Microbial source tracking (MST) is a useful tool to help differentiate sources of fecal indicator bacteria. Human markers along with a variety of other bird and animal markers can be identified. While human sources of fecal pollution are critical to eliminate, it is also important to minimize other sources that can cause illness in humans, although the actual risk associated with these other sources may fall within "acceptable" levels of risk. MST can help inform selection of BMPs discussed in Section 10.3 for fecal coliform to best align with the pollution source.

Fecal Bacteroidetes, or fecal indicator bacteria, are used in MST. Two common types of testing are available for bacterial source tracking, quantification tests and presence/absence tests. While presence/absence tests are typically less expensive than a quantification test, they do not measure the relative amount of DNA from various fecal sources, which might be used to estimate the relative abundance of those sources. Neither test, however is able to determine exact source location (i.e., this farm is contributing the most fecal coliform loads). Best professional judgement from site surveys and local knowledge can help determine source locations.

MST monitoring and sample collection methods are similar to fecal coliform sampling procedures. They should include both dry and wet (samples taken within at least 24 hours of a rainfall of ½ inches or more) samples, and target areas with high levels of fecal coliform. Topography, watershed delineations, and other factors may also influence sample design.

10.9.3 BMP Effectiveness Monitoring

Multiple BMPs will be needed to address the water quality impairments in the watershed. There are limited local data on the effectiveness of many BMPs; therefore, monitoring the results of programs and representative practices are critical. BMP monitoring can include quantitative monitoring of physical components (e.g., water quality and flow), qualitative (i.e., visual) monitoring of physical components (e.g., vegetation), and monitoring of behaviors. A monitoring program should be put in place as both structural and nonstructural BMPs are implemented to (1) measure success and (2) identify changes that could be made to increase effectiveness.

10.10 Reasonable Assurance

U.S. EPA requires that a TMDL provide reasonable assurance that the required load reductions will be achieved and water quality will be restored. For municipal point source dischargers and CAFOs in the watershed, Illinois EPA will assure implementation of TMDLs through its NPDES programs. Participation of farmers and landowners is essential to implementing nonpoint source BMPs and improving water quality, but resistance to change and upfront cost may deter participation. Educational efforts and cost-share programs will likely increase participation to levels needed to protect water quality. Technical and financial assistance, as summarized in Section 10.5, provides the resources needed to improve water quality and meet watershed goals. Contracts, memorandum of understandings, nutrient management plans/reports, etc. for reasonable assurance

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Appendix A. Critical Buffer Area Indicators

AUID (IL)	NAME	Barren Land	Cultivated Crops	Deciduous Forest	Developed, High Intensity	Developed, Low Intensity	Developed, Medium Intensity	Developed, Open Space	Emergent Herbaceous Wetlands	Evergreen Forest	Hay/Pasture	Herbaceous	Open Water	Shrub/Scrub	Woody Wetlands	Grand Total
DG-01	LA MOINE R		0.07	22.8		0.86	0.53	0.95			0.33	0.39	42.66		204.73	273.34
DG-02	LA MOINE R		0.14	39.2		1.41		0.19	0.02		0.00		3.37		134.26	178.60
DG-04	LA MOINE R		0.10	34.1		1.67	0.44		0.86		0.82				99.33	137.31
DG-06	LA MOINE R		0.42	7.50		0.27		0.18			0.08		3.59		145.59	157.65
DG-07	LA MOINE R		0.20	13.5		0.25					0.10				83.81	97.89
DG-08	LA MOINE R		0.10	63.2		0.01	0.21	0.90			2.55				45.29	112.29
DG-09	LA MOINE R	0.27	0.02	50.3			1.03				0.01	0.13			40.20	92.01
DG-10	LA MOINE R		36.0	311.8		4.44		5.17			49.7				57.97	465.08
DGA-01	LA MOINE R, TOWN BR		4.16	92.1		2.12	0.53	4.83			6.57		3.07		4.93	118.30
DGAA	Sand Branch		1.77	35.7							0.06					37.54
DGB-01	West Creek		8.42	102.9		2.64		3.29			28.1	0.15			6.95	152.44
DGC	NORTH FORK SHELBY CR		0.75	68.0		0.36		1.49			0.17				3.86	74.61
DGCA	South Fork Shelby Cr		9.28	81.6		0.94	0.23	0.88			7.00				1.15	101.08
DGD-01	MISSOURI CR		17.9	223.8		2.90	0.35	2.98			20.9				64.14	333.11
DGDA-01	LITTLE MISSOURI CR		2.47	154.9		2.20	0.29	1.60			4.17				15.29	180.93
DGDB	South Branch		12.1	72.3		1.11		3.06			1.11					89.70
DGDC	Grand Tower Branch		10.0	32.3		0.26	0.22				4.09		0.15	0.00	0.38	47.42
DGEA	Clark Branch		4.00	57.8		1.31		2.56			20.9	0.04			6.43	93.00
DGF	Stony Creek		6.50	100.2		1.32		0.62			13.4				13.05	135.04
DGFA	Brushy Creek		3.28	102.2		0.88		0.54			5.12				8.60	120.57
DGG-01	CEDAR CR		0.03	20.3		0.28	0.47	0.02			0.00				9.73	30.83
DGG-02	CEDAR CR		21.7	208.3		0.63		2.39			9.94	0.51			16.26	259.73
DGGA	Little Cedar Creek		4.84	52.0		2.14		1.02			16.1		2.67			78.73
DGGB	South Fork Creek		15.3	85.4		0.69		0.71			13.0			1.55		116.68
DGGC	S Br, Cedar Creek So		5.27	34.3		1.45		0.71			13.4					55.18
DGH-01	FLOUR CR		43.4	209.7		3.98	0.33	2.95			19.5				12.76	292.59
DGHA-01	WILLIAMS CR		20.1	196.0		3.29		2.15			11.3				2.83	235.66
DGI-01	CAMP CR		62.9	222.7		4.91	0.33	4.90	0.78		63.4			0.04	48.42	408.34
DGIA-03	GRINDSTONE CR	0.55	33.8	124.9		3.40	0.19	1.99			36.0	0.01			40.84	241.67
DGJ-01	TROUBLESOME CR		50.3	99.2		2.08	0.28	2.99			63.5	0.03			90.37	308.77
DGJA-01	Killjordan Creek		1.55	26.4		0.49	0.01	0.23			4.72	0.00			11.76	45.12
DGJA-02	Killjordan Creek			46.2	0.03	12.92	1.43	9.12			7.67					77.40
DGK-01	BRONSON CR		16.9	138.4		2.66		1.27			23.6	0.00			32.85	215.70
DGKA	Panther Creek		7.40	110.4		2.63		0.71			18.6			0.02	2.01	141.87
DGL-02	LA MOINE R, E FK		0.06	38.9	0.46	0.54					0.81				43.90	84.67

AUID (IL)	NAME	Barren Land	Cultivated Crops	Deciduous Forest	Developed, High Intensity	Developed, Low Intensity	Developed, Medium Intensity	Developed, Open Space	Emergent Herbaceous Wetlands	Evergreen Forest	Hay/Pasture	Herbaceous	Open Water	Shrub/Scrub	Woody Wetlands	Grand Total
DGL-03	LA MOINE R, E FK	0.09	1.07	68.9		1.00	1.69					0.91			22.04	95.67
DGL-04	LA MOINE R, E FK		1.14	95.8		2.87	1.00	3.19		0.01	1.96			0.02	73.42	179.44
DGL-05	LA MOINE R, E FK		55.8	108.7		7.43	0.45	1.42			93.2				0.45	267.49
DGL-08	LA MOINE R, E FK		2.22	22.9		1.04					5.72				22.32	54.24
DGLA-01	Spring Creek		12.5	107.5		1.79		0.41			9.45		0.01		1.58	133.18
DGLC-01	LA MOINE R, DROWNING		176.4	32.6		3.46	0.69	3.03	1.10		9.72				0.68	227.69
DGLCA	Kepple Creek		67.6	30.5		4.38		1.89			18.4				0.59	123.39
DGLD-01	LA MOINE R, FARMERS		61.1	62.5		2.57	0.75	0.80			33.3					160.93
DGLDA	Town Fork		35.7	61.2		6.50	0.49	1.46			27.7			0.51		133.65
DGLE	Short Fork		36.0	42.9		1.52	0.44	1.67			25.9					108.54
DGLF	North Fork East Fork		38.9	9.41		0.96		0.58			31.6					81.54
DGLG	Little Creek		16.2	8.58		1.95	0.63	0.24			31.8					59.39
DGM	Middle Creek		40.9	57.3		2.50	3.16	2.21			27.6				12.72	146.46
DGMA	Little Creek		17.7	72.1		2.60		0.08			14.1			0.90	1.52	109.06
DGN-01	Cedar Creek		11.3	131.4		1.47		1.39			14.4	0.21		0.58	10.86	171.68
DGNA	Fisher Creek		2.13	53.0		0.71					2.94					58.84
DGO-01	Rock Creek		45.8	96.1		3.21	0.23	1.02			13.4			1.01	2.29	163.11
DGOA	Short Creek		3.11	31.3		2.71					28.1					65.23
DGP	LA HARPE CR		33.0	167.0		5.91		0.26			21.5				1.68	232.34
DGP-01	LA HARPE CR		0.29	51.1		0.54		0.55			5.67				33.10	91.23
DGPA	Dunbar Creek		5.03	27.0		1.18					20.9				2.47	56.52
DGPB-01	ROCK CR		32.0	100.3		2.24		3.10			24.7				3.25	165.51
DGPC-01	BAPTIST CR		15.8	105.5		3.60		1.06			44.5	0.03			1.80	172.31
DGPCA	Little Creek		35.7	98.1		3.01		6.16			10.4					153.40
DGQ-01	GROVE CR		19.1	117.1		3.37	0.24				22.3				3.81	165.91
DGQA	Wildcat Creek		14.4	28.4		1.14		0.36			5.25			0.18		49.76
DGRA	Voel Creek		7.28	75.3		2.95		1.65			23.0					110.12
DGZB	Logan Creek		0.36	128.33		0.85		0.62			17.6		0.06		2.99	150.86
DGZD-01	LA MOINE R, HORNEY B		6.91	106.3		2.26	0.15	1.37			14.5				6.41	137.85
DGZE	Spring Branch		0.80	45.4		0.40		1.21			1.01				3.32	52.13
IL_DGZF	Fowler Branch		9.93	59.9		0.91					13.2				8.70	92.67
DGZG	Horney Branch		3.76	73.3		1.85	0.56	0.11			0.53				12.34	92.47
DGZH	Willow Creek		18.5	58.6		1.08	0.72	0.48			6.44		6.31		2.60	94.74
DGZI	Lewis Creek		21.8	39.4		1.85		1.23			6.02				1.23	71.60
DGZJ	Harrison Branch		10.5	74.65		1.79		1.45			5.81				7.18	101.35
DGZK	Beckford Branch		7.90	42.26		0.55		0.20			5.18				3.53	59.61
DGZN-01	Prairie Creek		20.9	69.71		1.03	1.19	0.22			28.5	0.04			1.37	122.94
DGZO-01	LONG CR		20.9	142.3		3.50	0.40	0.56			5.02	0.02		0.06	0.60	173.34
DGZQ	Spring Creek North		23.8	68.7		2.15		1.38			18.7				0.15	114.95

AUID (IL)	NAME	Barren Land	Cultivated Crops	Deciduous Forest	Developed, High Intensity	Developed, Low Intensity	Developed, Medium Intensity	Developed, Open Space	Emergent Herbaceous Wetlands	Evergreen Forest	Hay/Pasture	Herbaceous	Open Water	Shrub/Scrub	Woody Wetlands	Grand Total
DGZR	LA MOINE R, S BR		25.0	143.1		3.07		0.94			29.6					201.72
RDN	Mt Sterling Lake			0.15			0.15						6.51			6.82
RDR	Spring Lake			4.91							4.56		37.31		0.69	47.47
	TOTALS	0.92	1,361	6,202	0.50	161	19.8	103	2.76	0.01	1,191	2.47	105.7	4.9	1,493	10,648

Appendix B. HUC12s in the La Moine River watershed